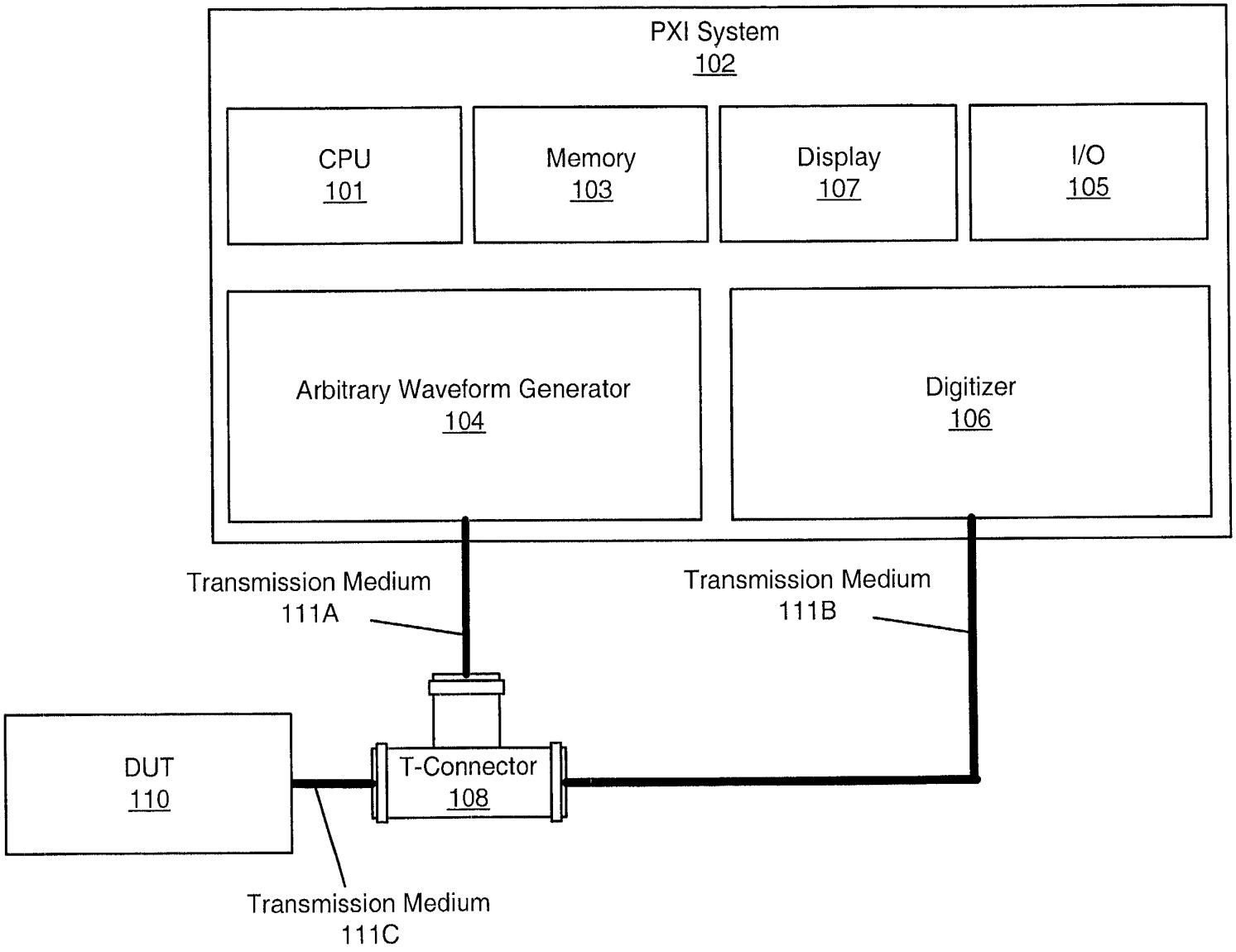
PXI System
102
CPU
101
Memory
103
Display
107
I/O
105
Arbitrary Waveform Generator
104
Digitizer
106
Transmission Medium
111A
Transmission Medium
111B
DUT
110
T-Connector
108
Transmission Medium
111C

Figure 1

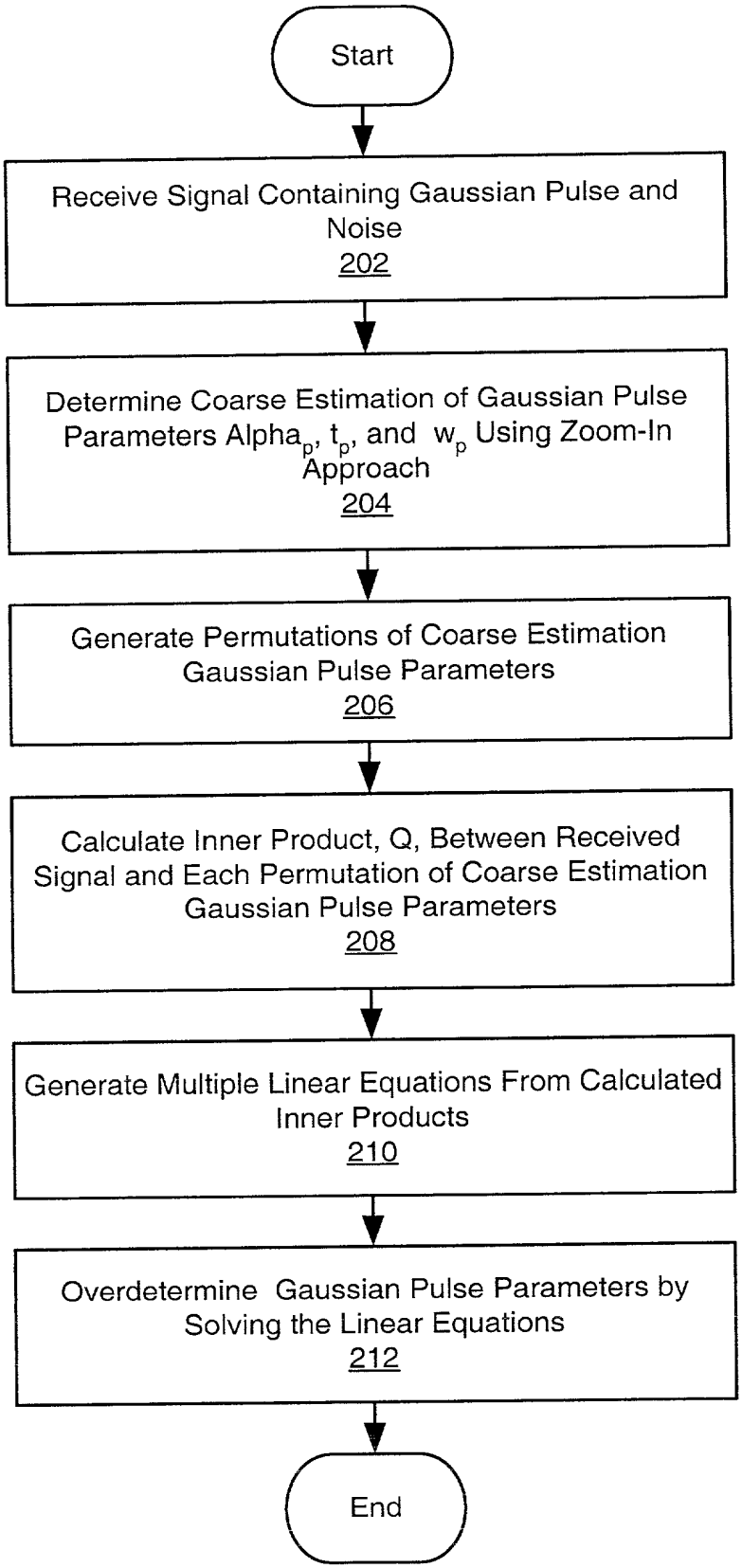
Start
Receive Signal Containing Gaussian Pulse and Noise
202
Determine Coarse Estimation of Gaussian Pulse Parameters Alpha$_p$, t_p, and w_p Using Zoom-In Approach
204
Generate Permutations of Coarse Estimation Gaussian Pulse Parameters
206
Calculate Inner Product, Q, Between Received Signal and Each Permutation of Coarse Estimation Gaussian Pulse Parameters
208
Generate Multiple Linear Equations From Calculated Inner Products
210
Overdetermine Gaussian Pulse Parameters by Solving the Linear Equations
212
End

Figure 2

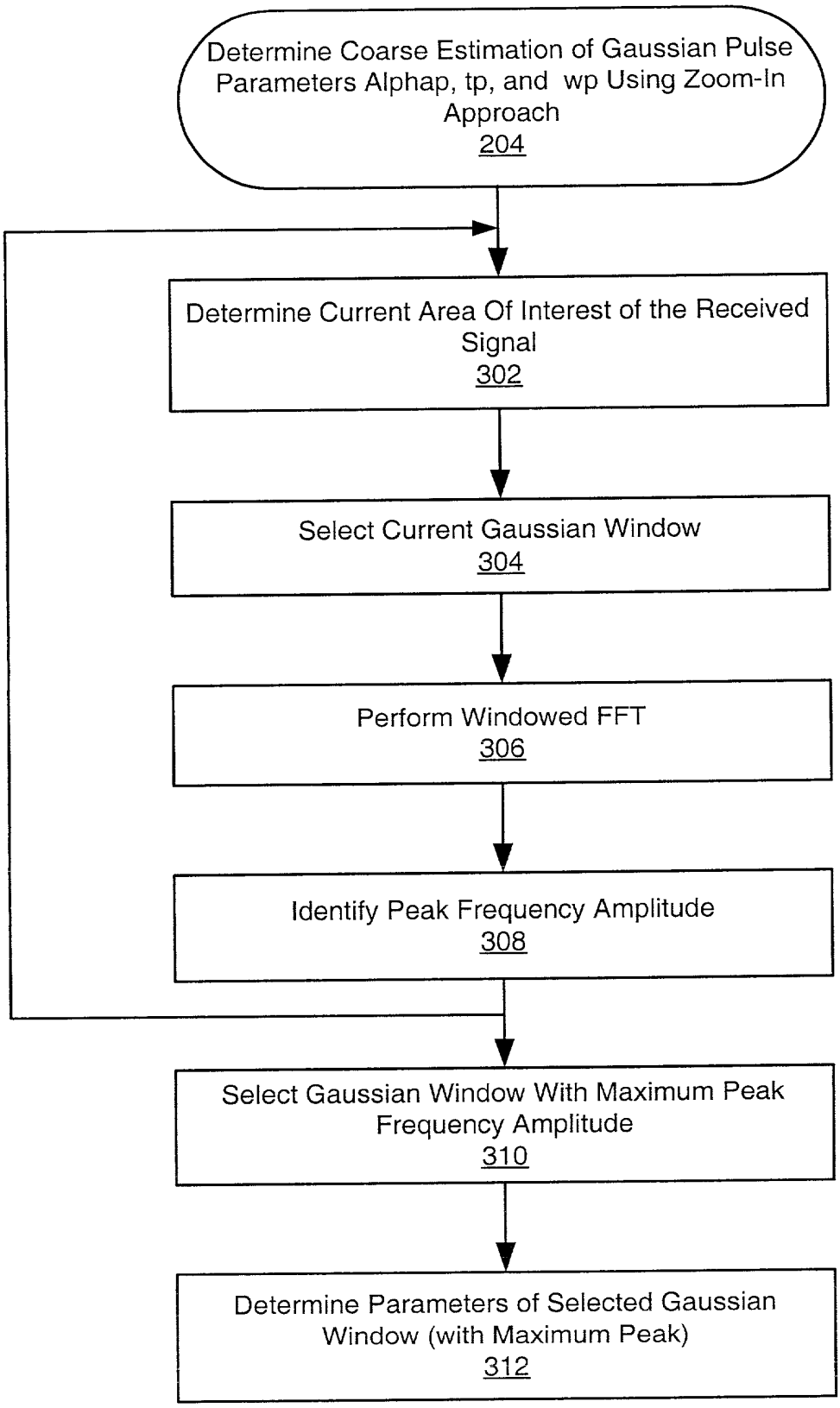
Determine Coarse Estimation of Gaussian Pulse Parameters Alphap, tp, and wp Using Zoom-In Approach
204
Determine Current Area Of Interest of the Received Signal
302
Select Current Gaussian Window
304
Perform Windowed FFT
306
Identify Peak Frequency Amplitude
308
Select Gaussian Window With Maximum Peak Frequency Amplitude
310
Determine Parameters of Selected Gaussian Window (with Maximum Peak)
312

Figure 3

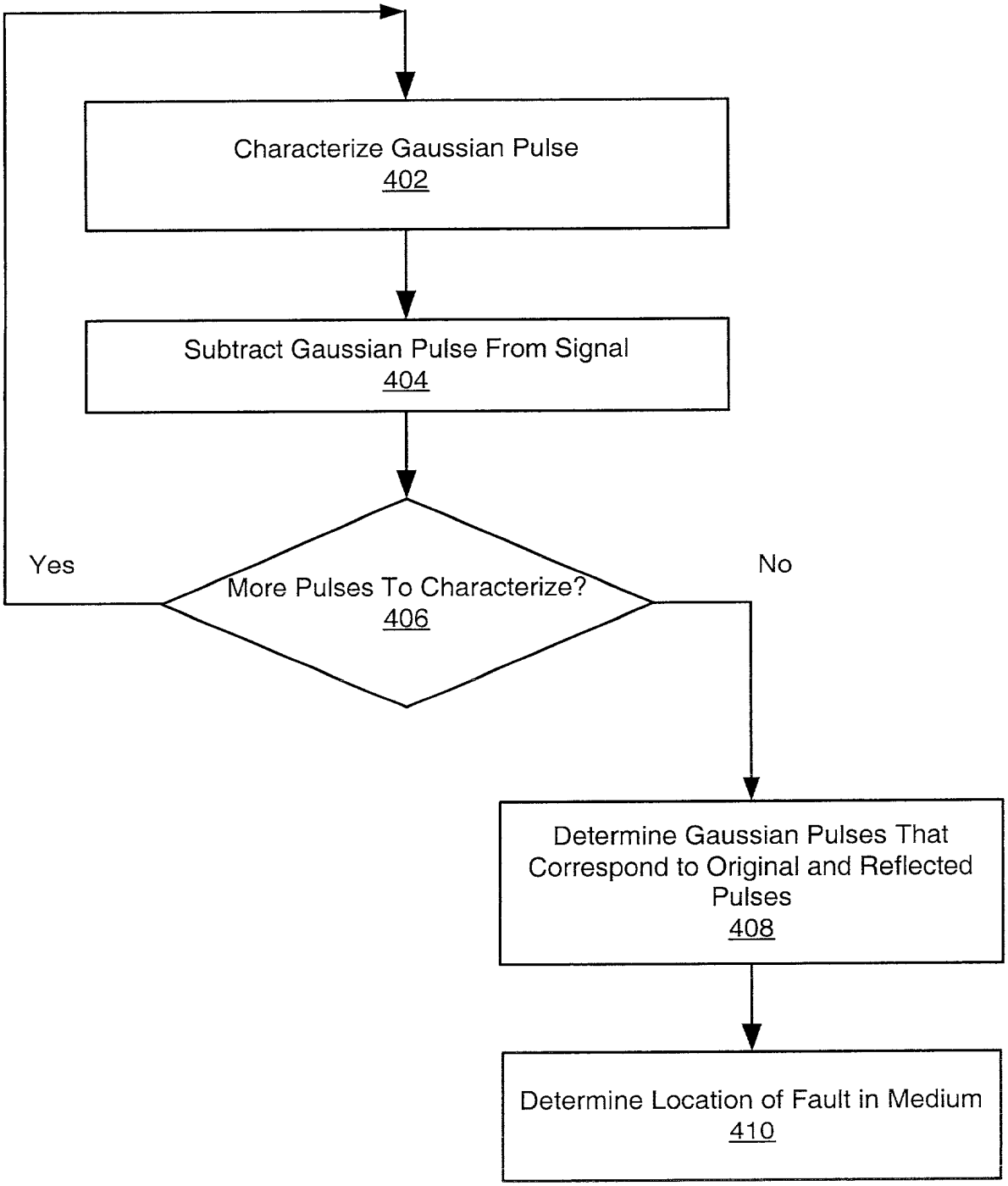
Characterize Gaussian Pulse
402
Subtract Gaussian Pulse From Signal
404
More Pulses To Characterize?
406
Yes
No
Determine Gaussian Pulses That Correspond to Original and Reflected Pulses
408
Determine Location of Fault in Medium
410

Figure 4

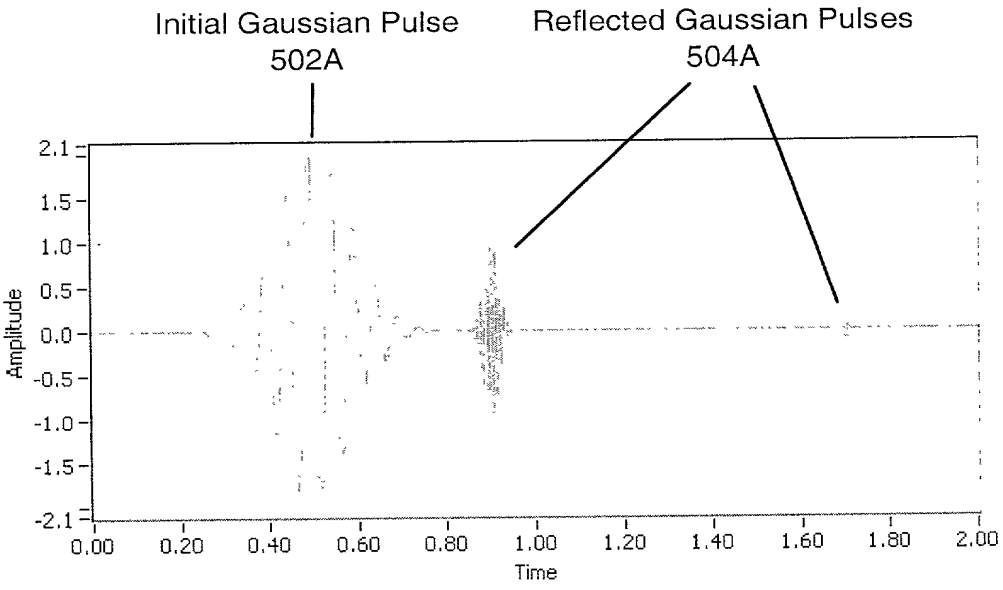

Figure 5A

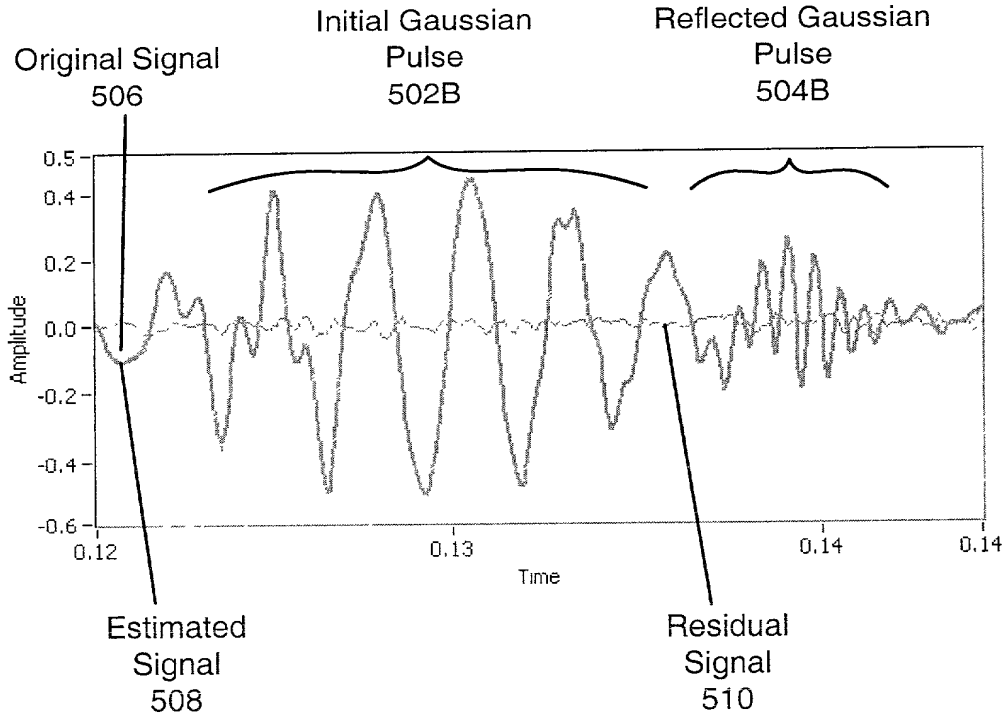

Figure 5B

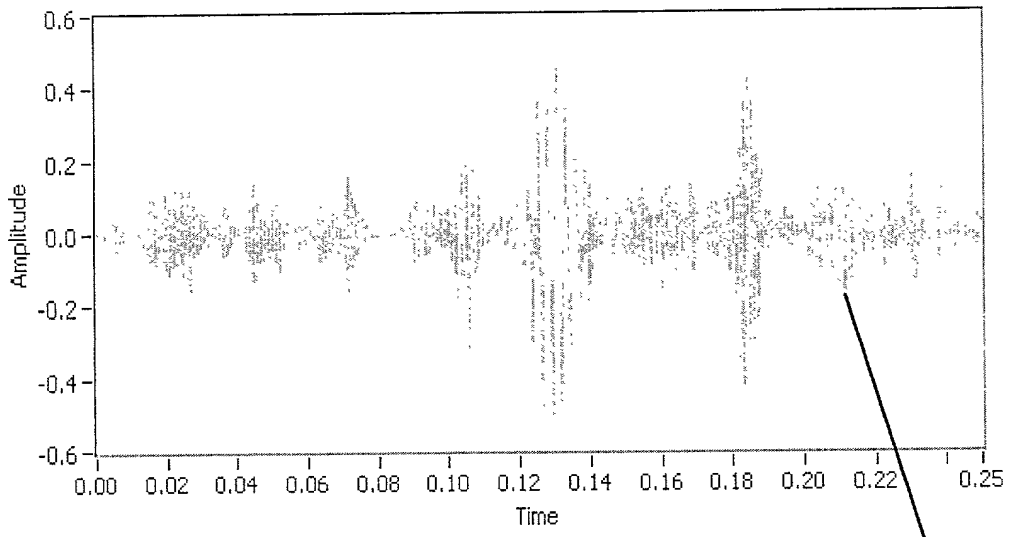

Figure 5C

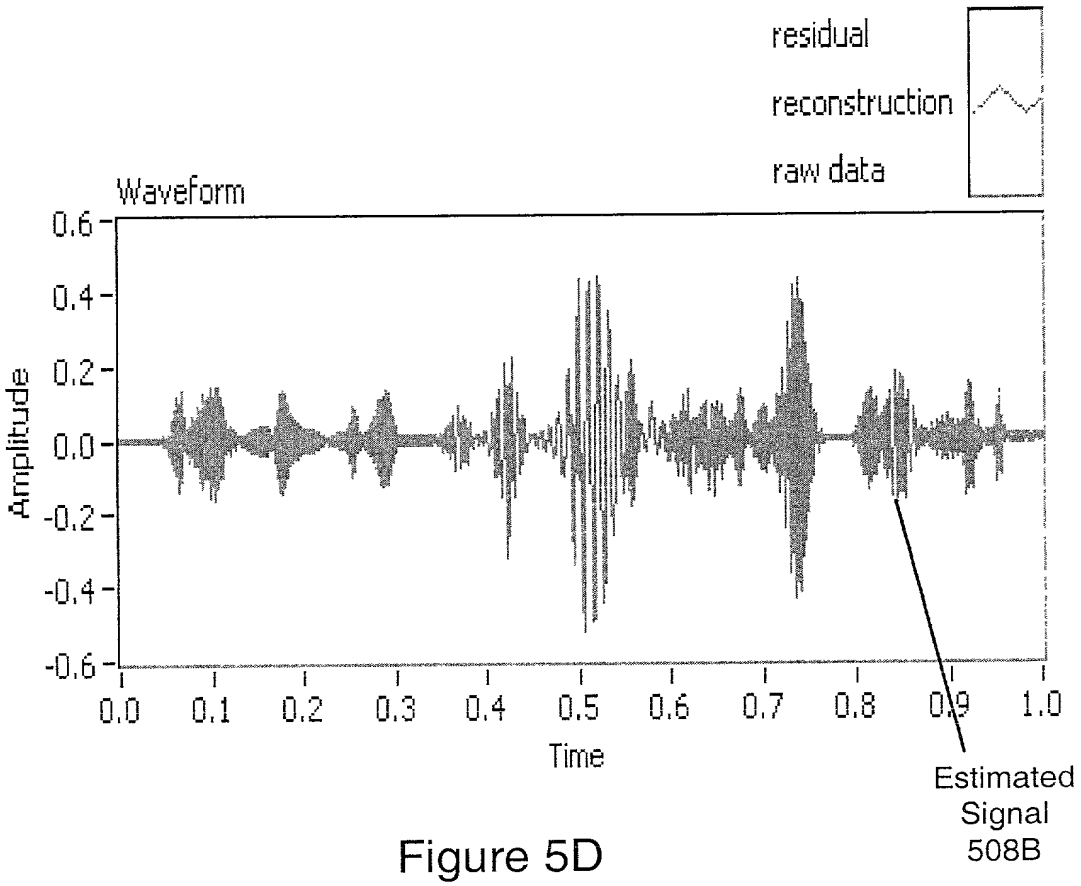

Figure 5D

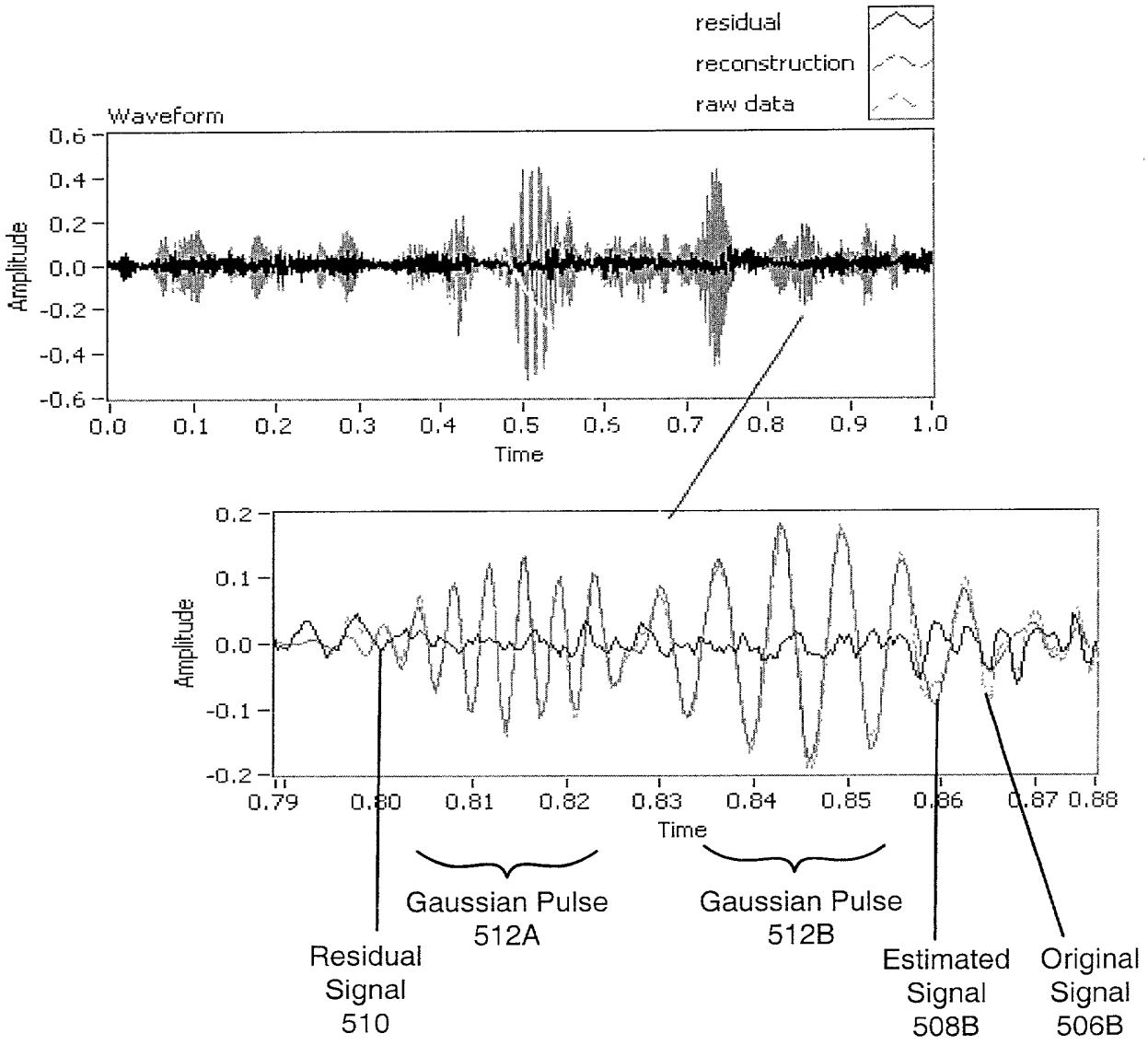
residual
reconstruction
raw data
Waveform
Amplitude
Time
Gaussian Pulse
512A
Gaussian Pulse
512B
Residual
Signal
510
Estimated
Signal
508B
Original
Signal
506B

Figure 5E

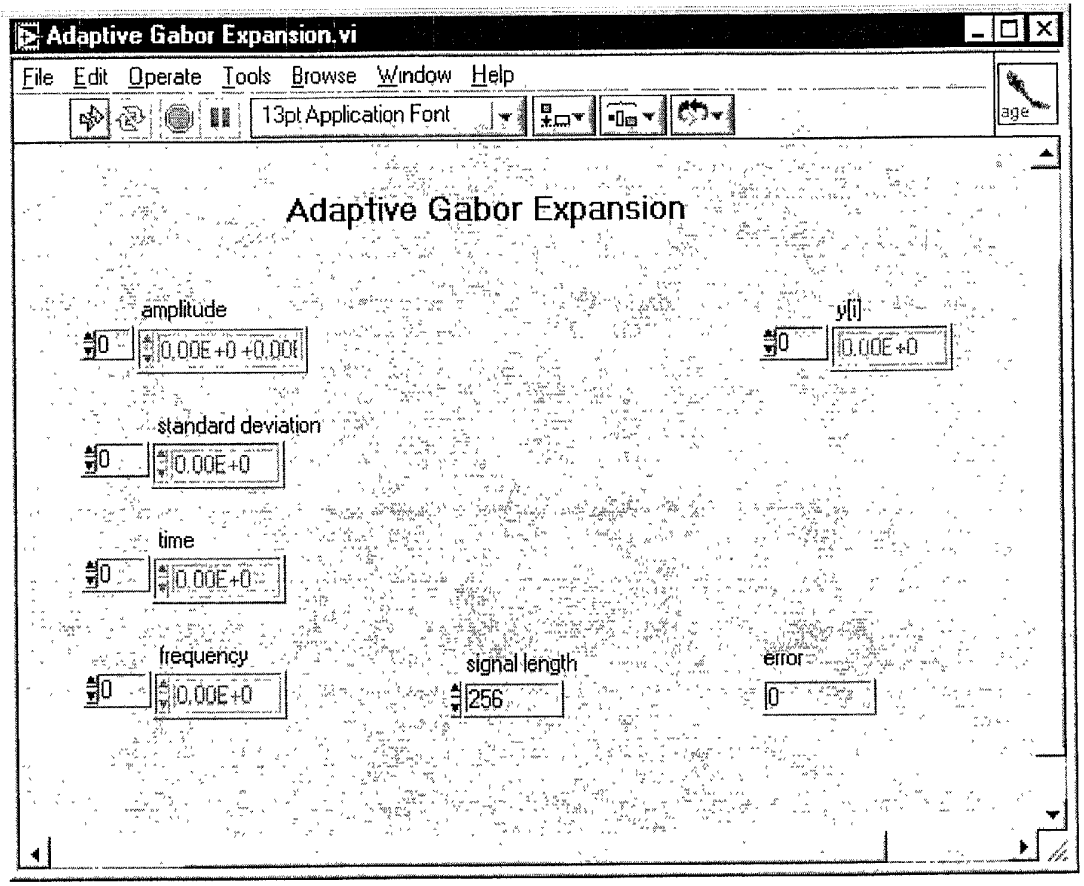
Adaptive Gabor Expansion.vi
File Edit Operate Tools Browse Window Help
13pt Application Font
Adaptive Gabor Expansion
amplitude
0
0.00E+0 +0.00E
standard deviation
0
0.00E+0
time
0
0.00E+0
frequency
0
0.00E+0
signal length
256
y[i]
0
0.00E+0
error
0

Figure 6A

TOCTOU 30SE3S60

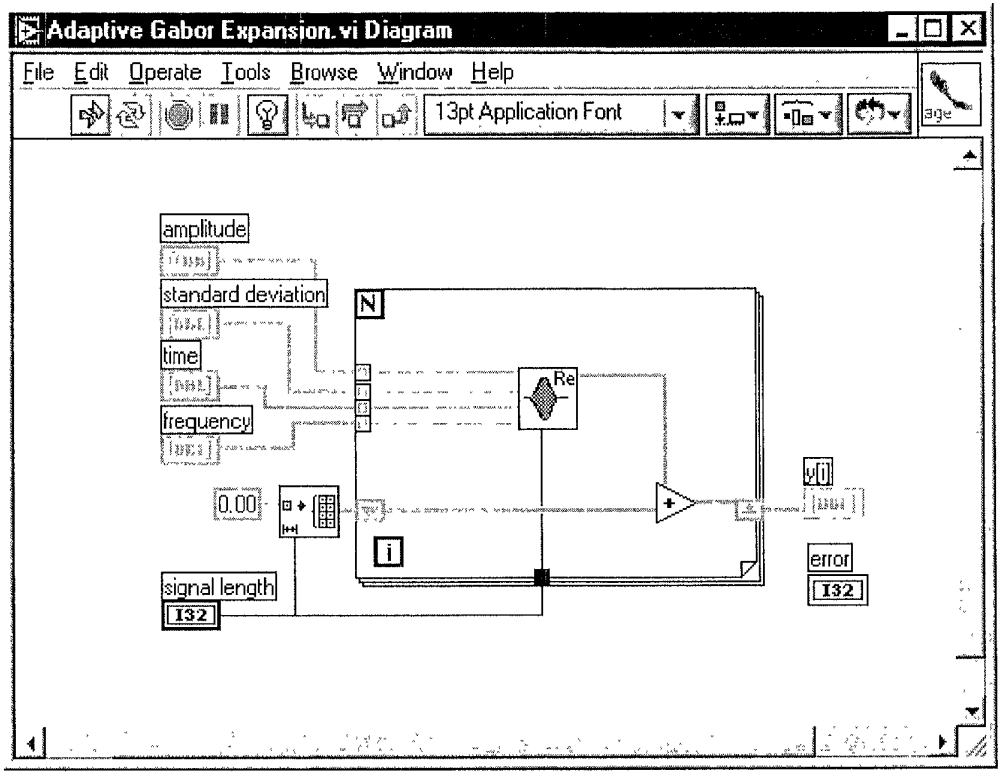

Figure 6B

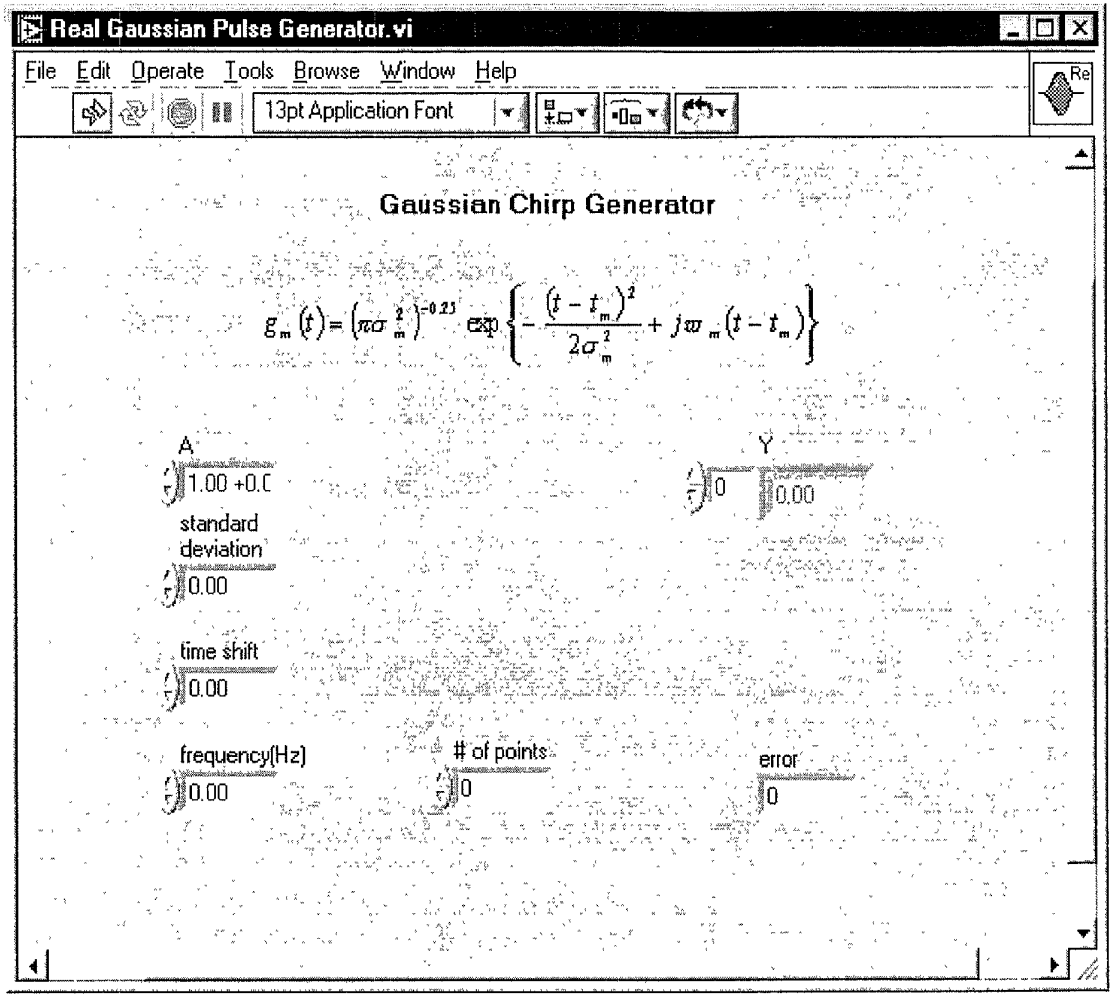
Real Gaussian Pulse Generator.vi
File Edit Operate Tools Browse Window Help
13pt Application Font
Gaussian Chirp Generator
$g_m(t) = (\pi\sigma_m^2)^{-0.25} \exp\left\{-\frac{(t-t_m)^2}{2\sigma_m^2} + jw_m(t-t_m)\right\}$
A
1.00 +0.0
standard deviation
0.00
time shift
0.00
frequency(Hz)
0.00
# of points
0
Y
0
0.00
error
0

Figure 7A

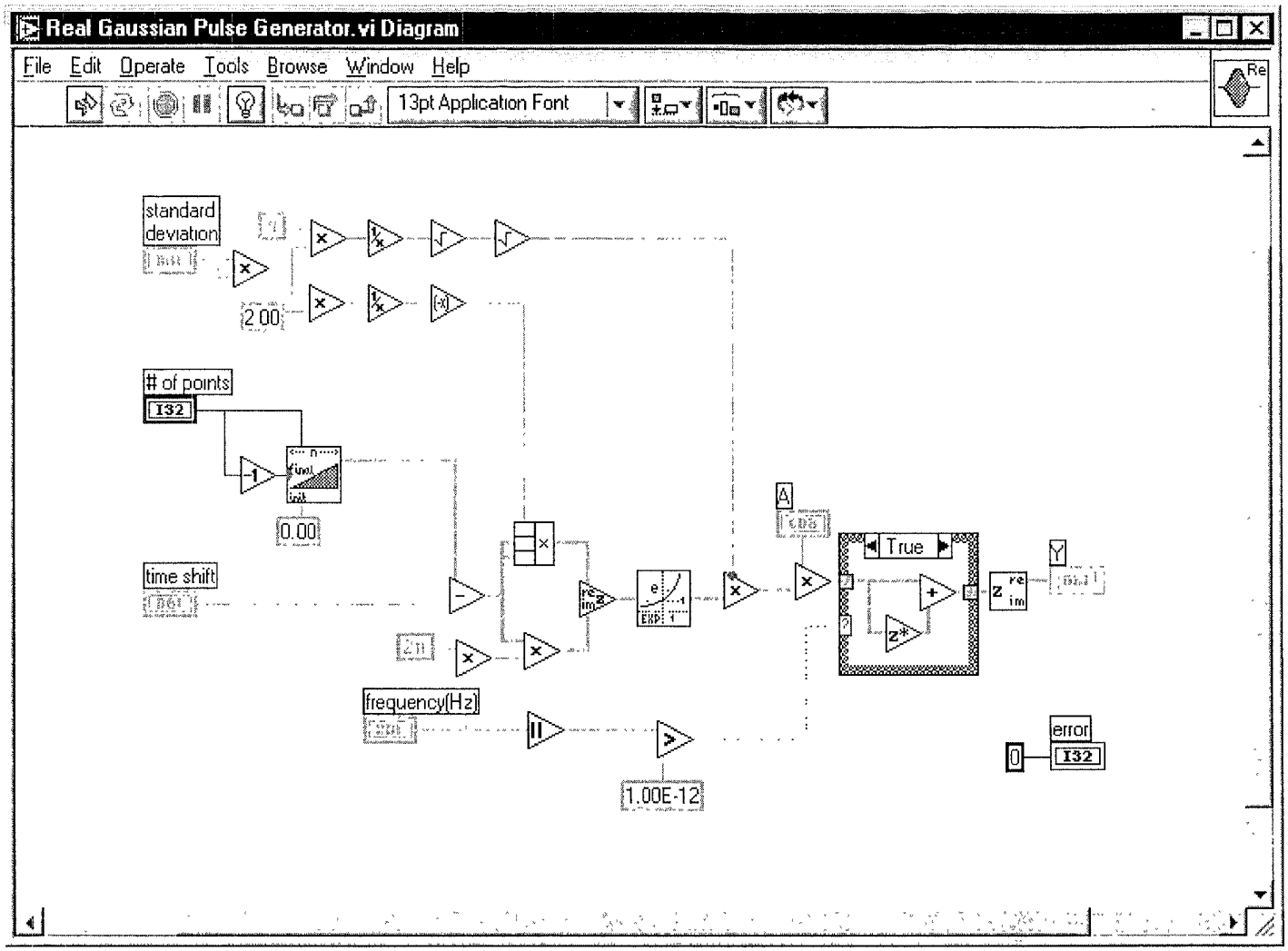
Real Gaussian Pulse Generator.vi Diagram
File Edit Operate Tools Browse Window Help
13pt Application Font
standard deviation
2.00
# of points
I32
0.00
time shift
frequency(Hz)
1.00E-12
True
error
I32
0

Figure 7B

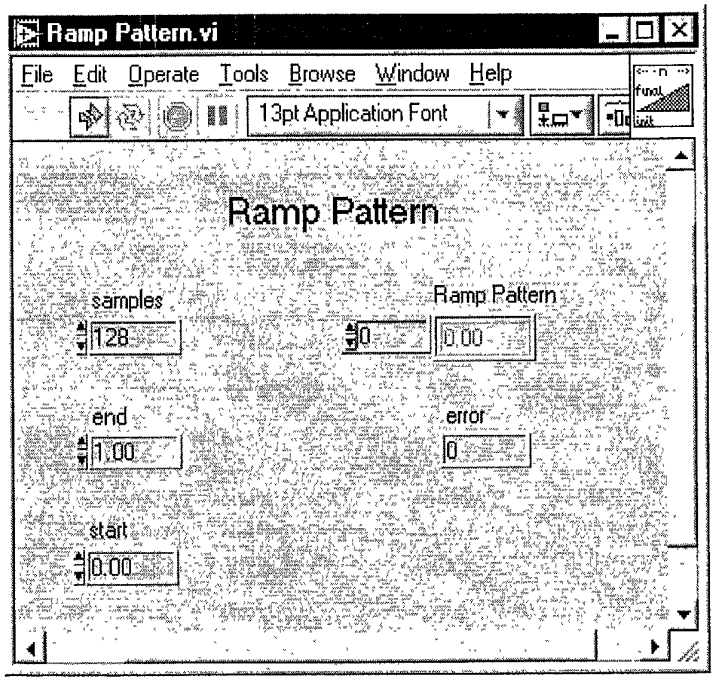
Ramp Pattern.vi
File Edit Operate Tools Browse Window Help
13pt Application Font
Ramp Pattern
samples
128
Ramp Pattern
0
0.00
end
1.00
error
0
start
0.00

Figure 8A

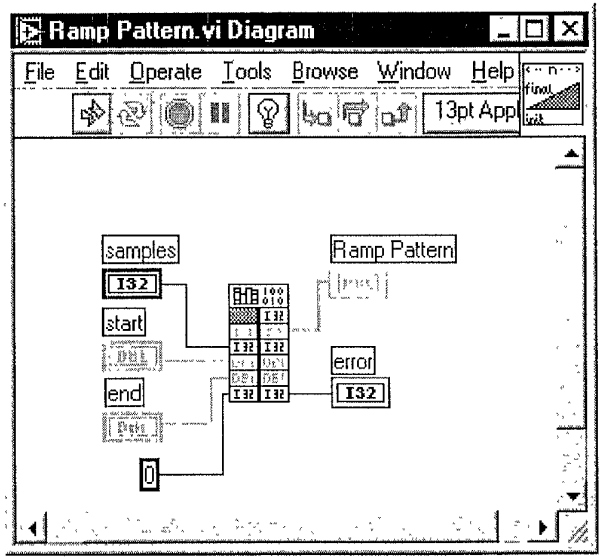
Ramp Pattern.vi Diagram
File Edit Operate Tools Browse Window Help
13pt App
samples
I32
start
DBL
end
DBL
0
Ramp Pattern
error
I32

Figure 8B

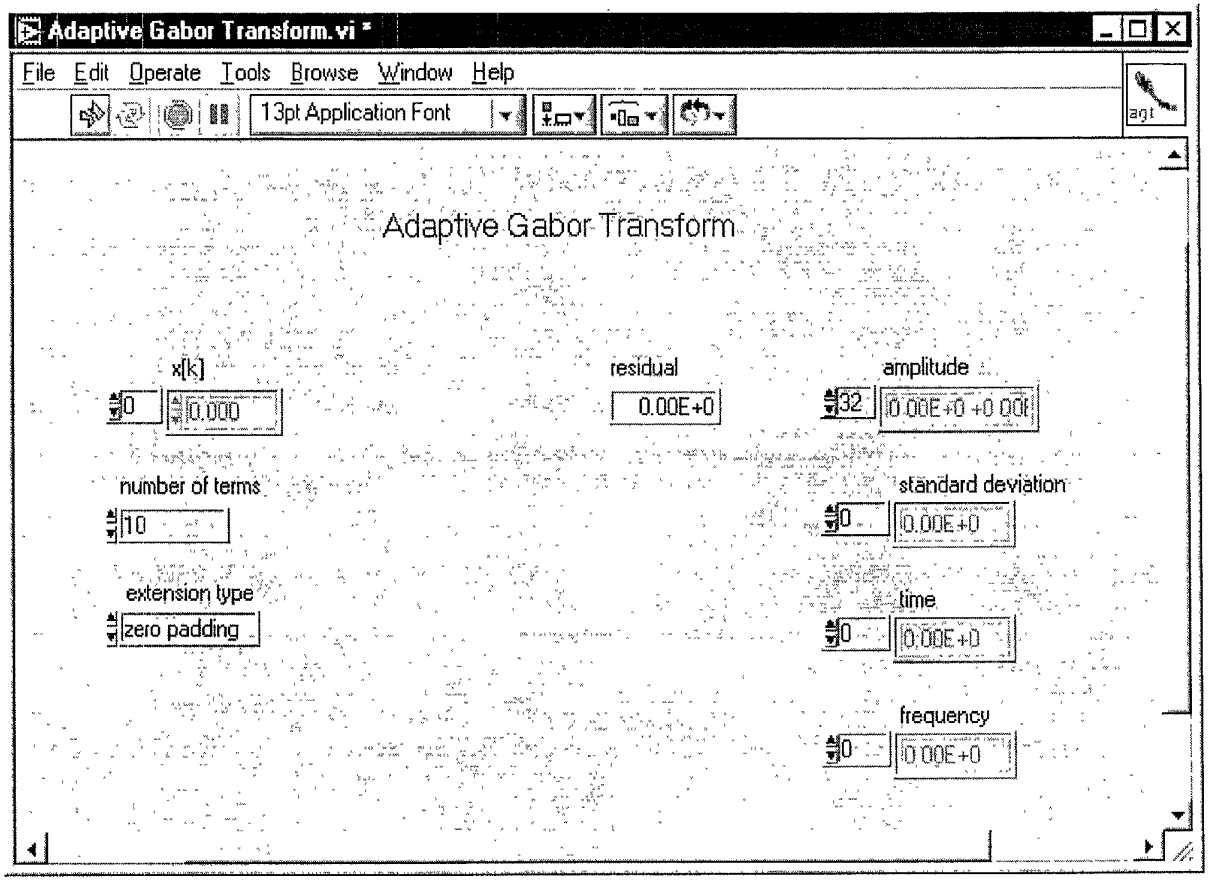
Adaptive Gabor Transform.vi *
File Edit Operate Tools Browse Window Help
13pt Application Font
Adaptive Gabor Transform
x[k]
0
0.000
residual
0.00E+0
amplitude
32
0.00E+0
number of terms
10
standard deviation
0
0.00E+0
extension type
zero padding
time
0
0.00E+0
frequency
0
0.00E+0

Figure 9A

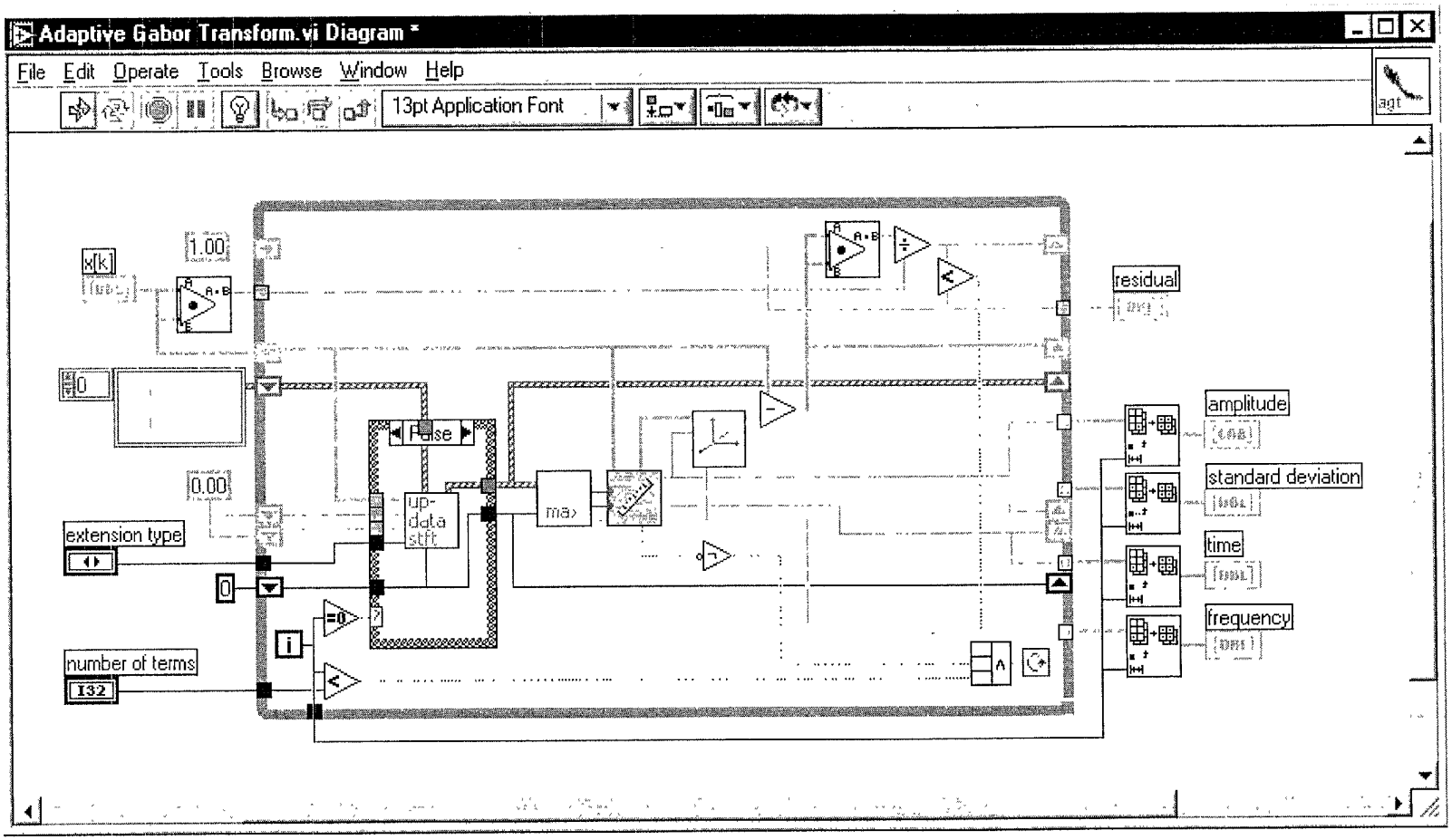
Adaptive Gabor Transform.vi Diagram *
File Edit Operate Tools Browse Window Help
13pt Application Font
x[k]
1.00
0
0.00
extension type
0
number of terms
I32
Raise
up-data stft
max
residual
amplitude
standard deviation
time
frequency

Figure 9B

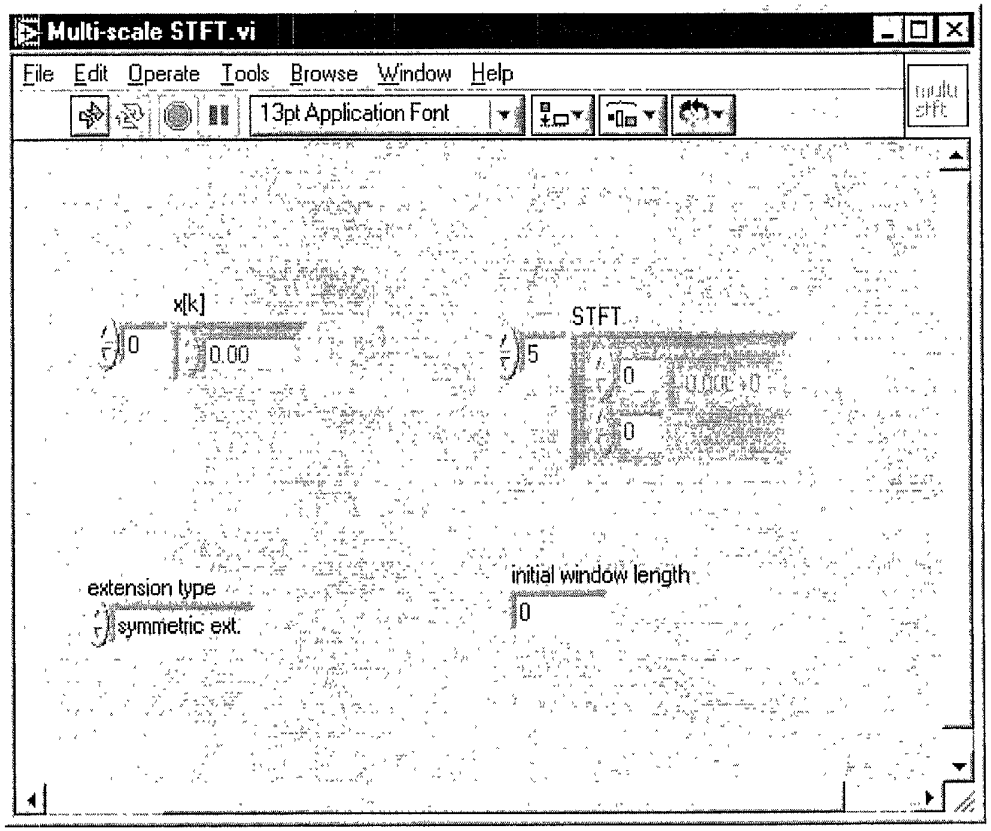
Multi-scale STFT.vi
File Edit Operate Tools Browse Window Help
13pt Application Font
multi stft
x[k]
0
0.00
STFT
5
0
0
extension type
symmetric ext.
initial window length
0

Figure 10A

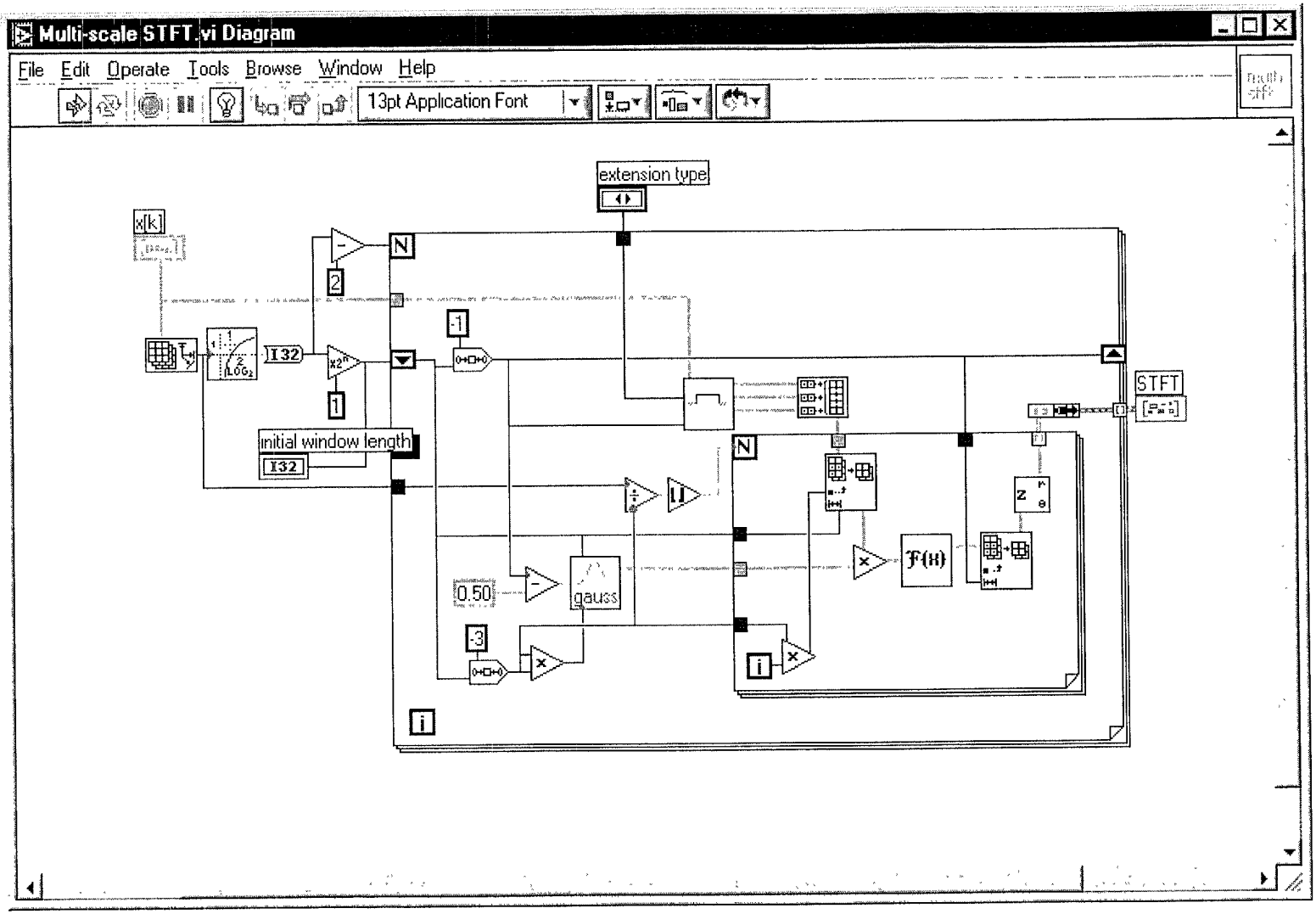
Multi-scale STFT.vi Diagram
File Edit Operate Tools Browse Window Help
13pt Application Font
extension type
x[k]
N
2
-1
I32
1
initial window length
I32
STFT
N
0.50
gauss
-3
i
i
F(H)

Figure 10B

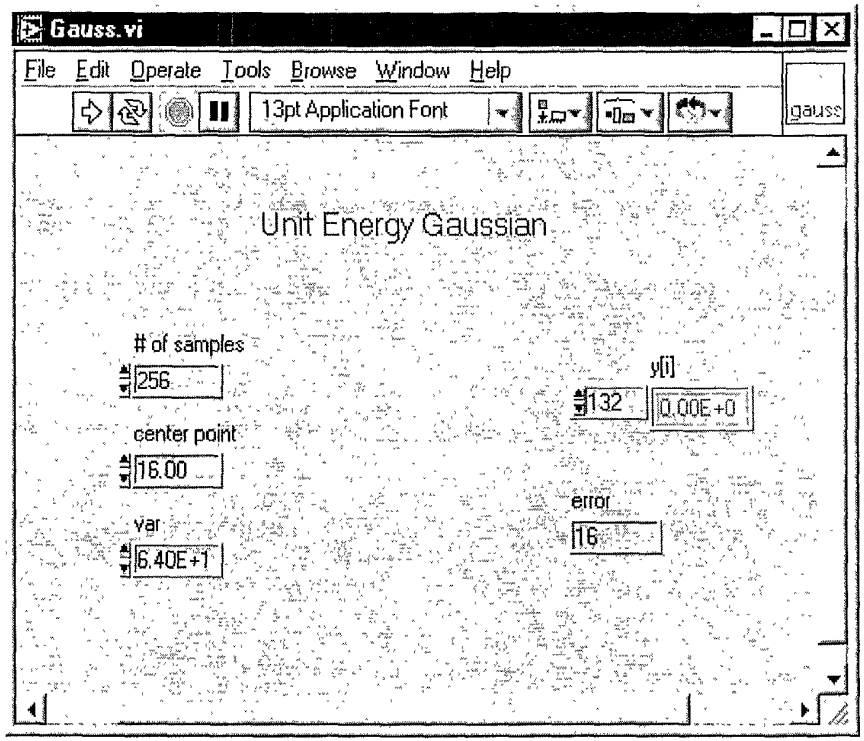
Gauss.vi
File Edit Operate Tools Browse Window Help
13pt Application Font
gauss
Unit Energy Gaussian
# of samples
256
center point
16.00
var
6.40E+1
y[i]
132
0.00E+0
error
16

Figure 11A

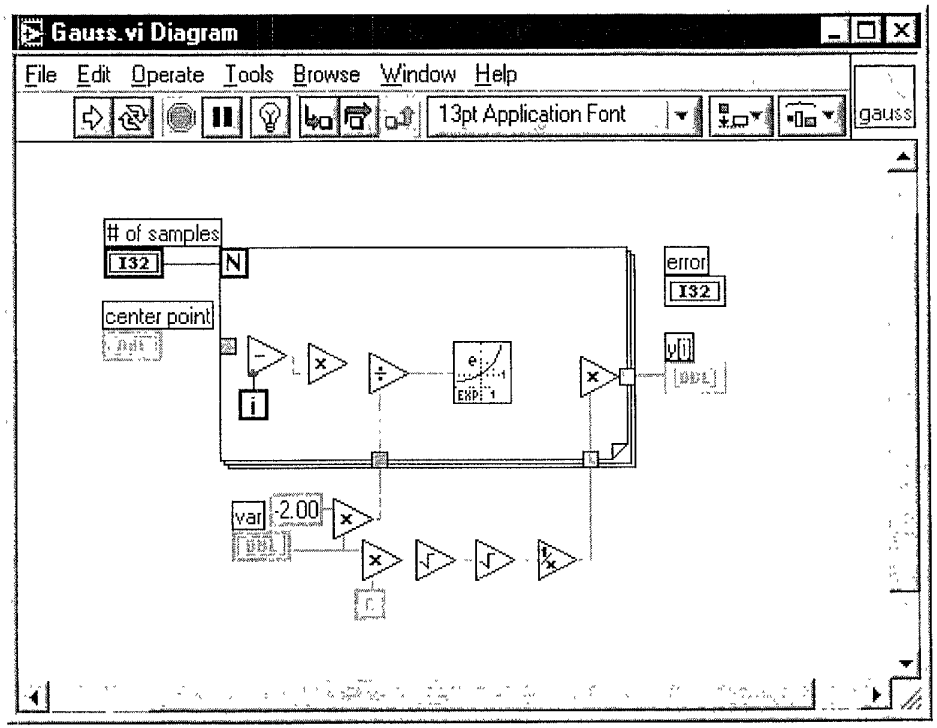
Gauss.vi Diagram
File Edit Operate Tools Browse Window Help
13pt Application Font
gauss
# of samples
I32
N
center point
error
I32
y[i]
DBL
i
EXP
var
2.00
DBL
0

Figure 11B

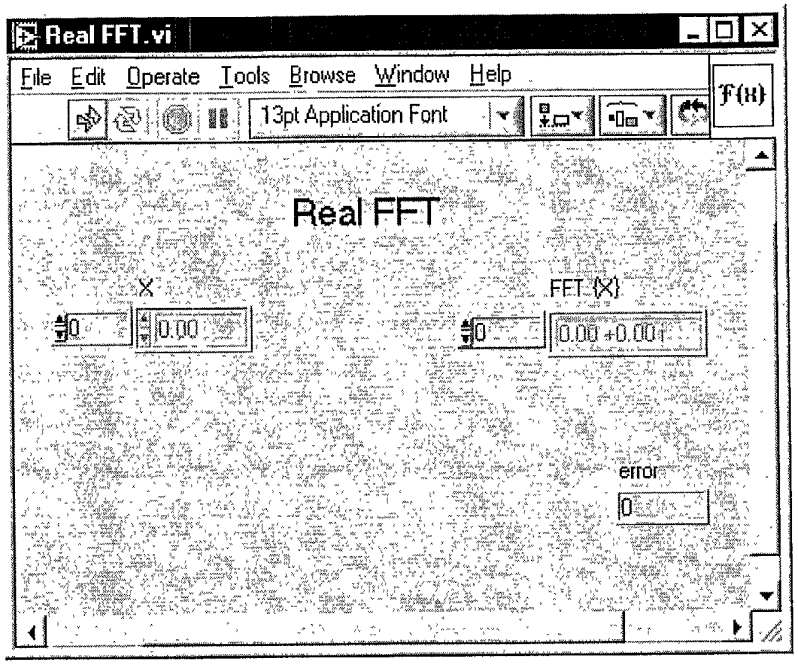
Real FFT.vi
File Edit Operate Tools Browse Window Help
13pt Application Font
F(8)
Real FFT
X
0
0.00
FFT(X)
0
0.00 +0.00i
error
0

Figure 12A

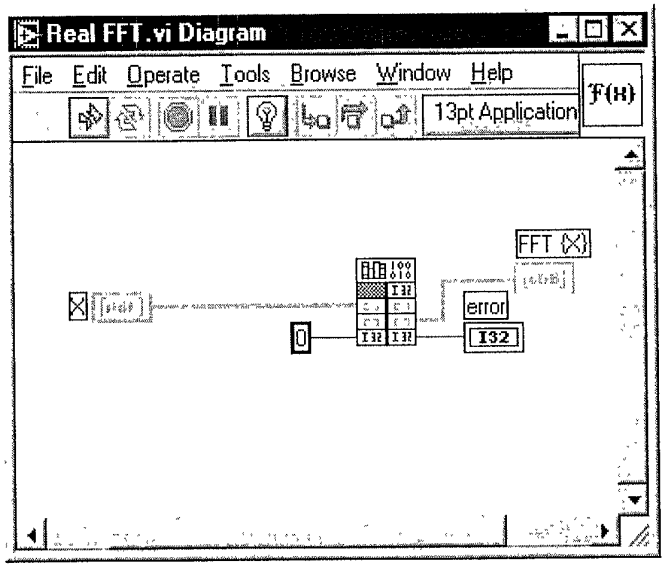
Real FFT.vi Diagram
File Edit Operate Tools Browse Window Help
13pt Application
FFT (X)
error
I32
0

Figure 12B

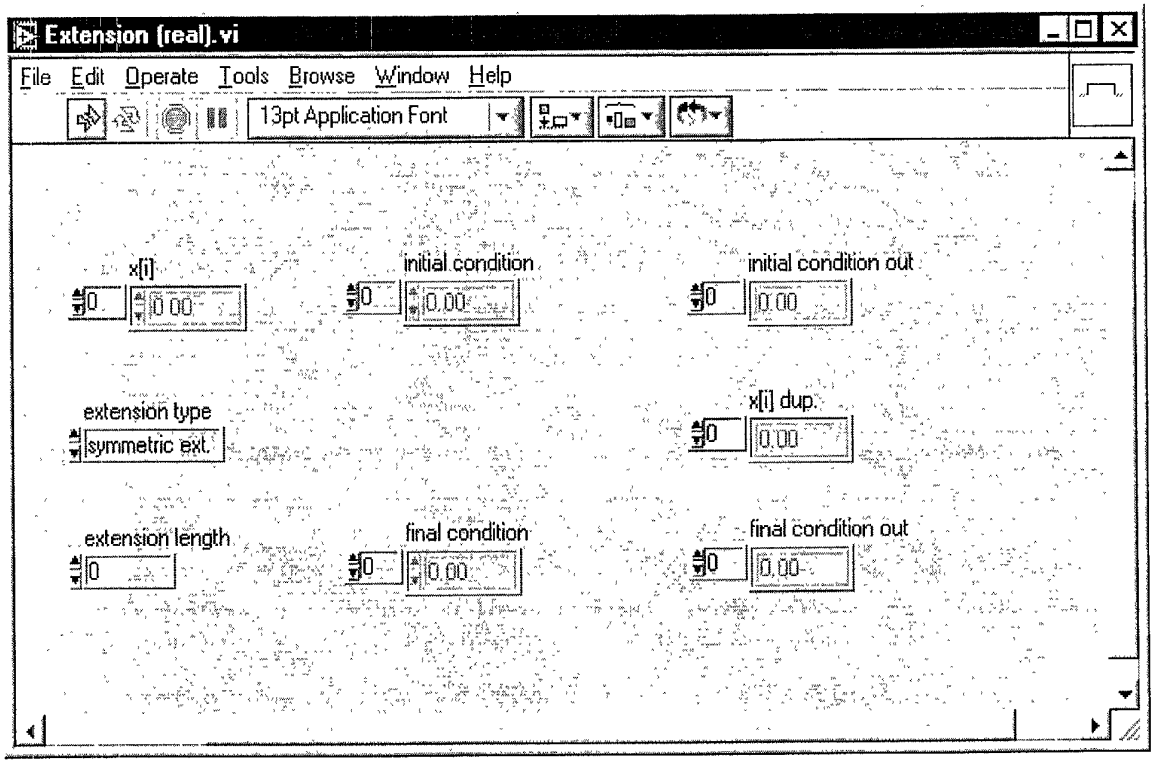
Extension (real).vi
File Edit Operate Tools Browse Window Help
13pt Application Font
x[i]
initial condition
initial condition out
extension type
symmetric ext.
x[i] dup
extension length
final condition
final condition out

Figure 13A

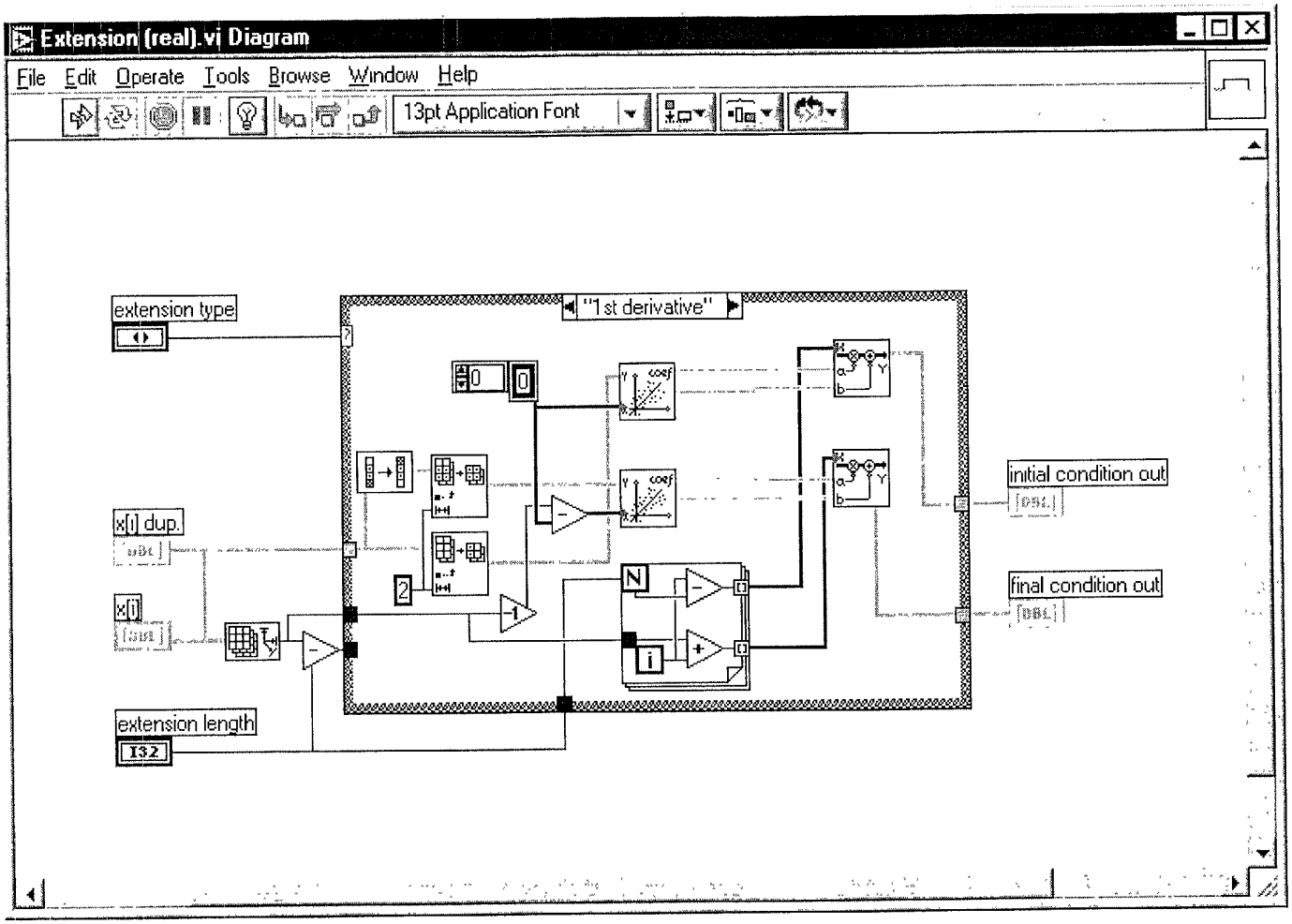
Extension (real).vi Diagram
File Edit Operate Tools Browse Window Help
13pt Application Font
"1st derivative"
extension type
x[i] dup.
x[i]
extension length
I32
initial condition out
final condition out

Figure 13B

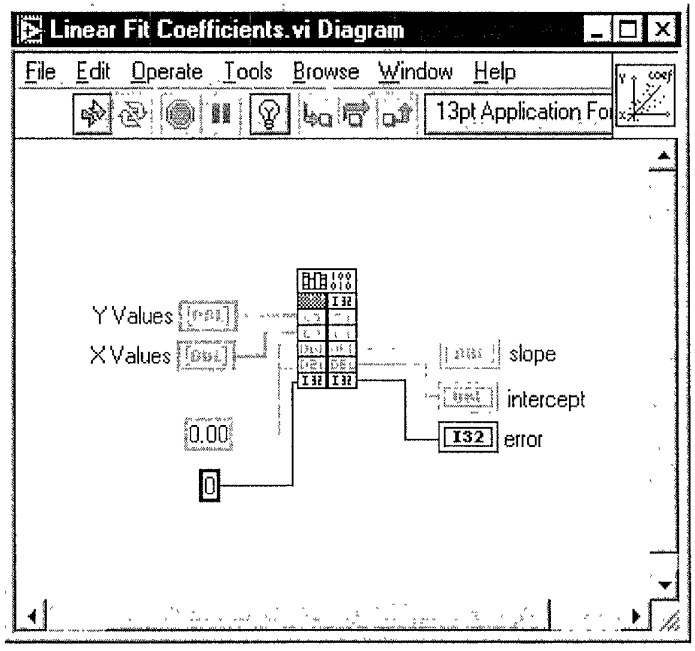
Linear Fit Coefficients.vi Diagram
File Edit Operate Tools Browse Window Help
13pt Application Fo
Y Values
X Values
0.00
0
slope
intercept
I32
error

Figure 14B

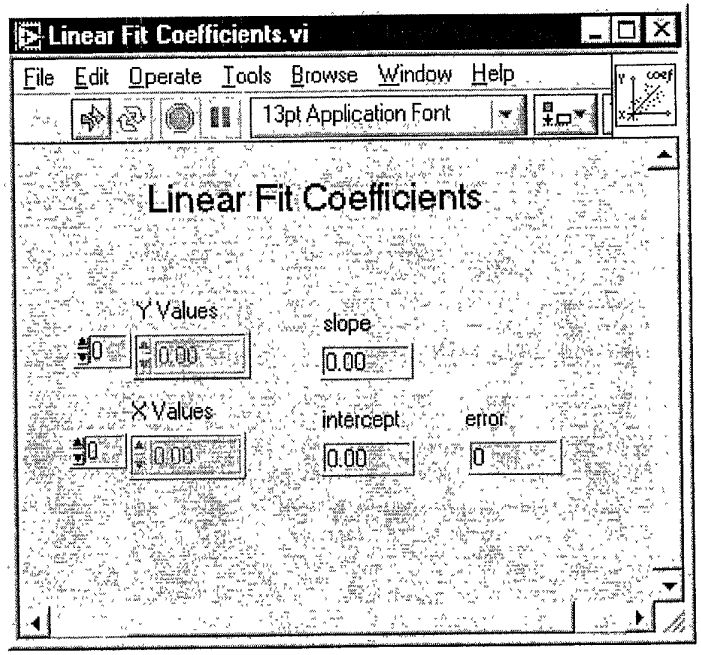
Linear Fit Coefficients.vi
File Edit Operate Tools Browse Window Help
13pt Application Font
Linear Fit Coefficients
Y Values
0
0.00
X Values
0
0.00
slope
0.00
intercept
0.00
error
0

Figure 14A

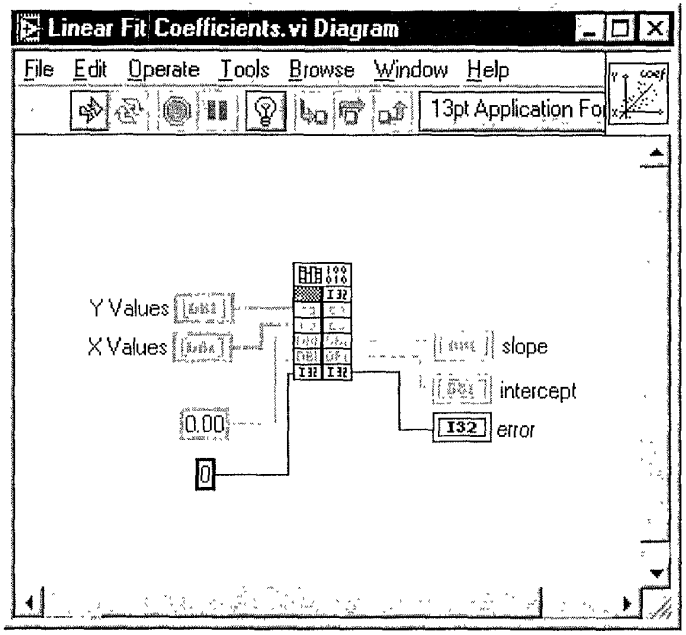
Linear Fit Coefficients.vi Diagram
File Edit Operate Tools Browse Window Help
13pt Application Fo
Y Values
X Values
0.00
0
slope
intercept
I32
error

Figure 14B

TOSTAD SOSSEBCD

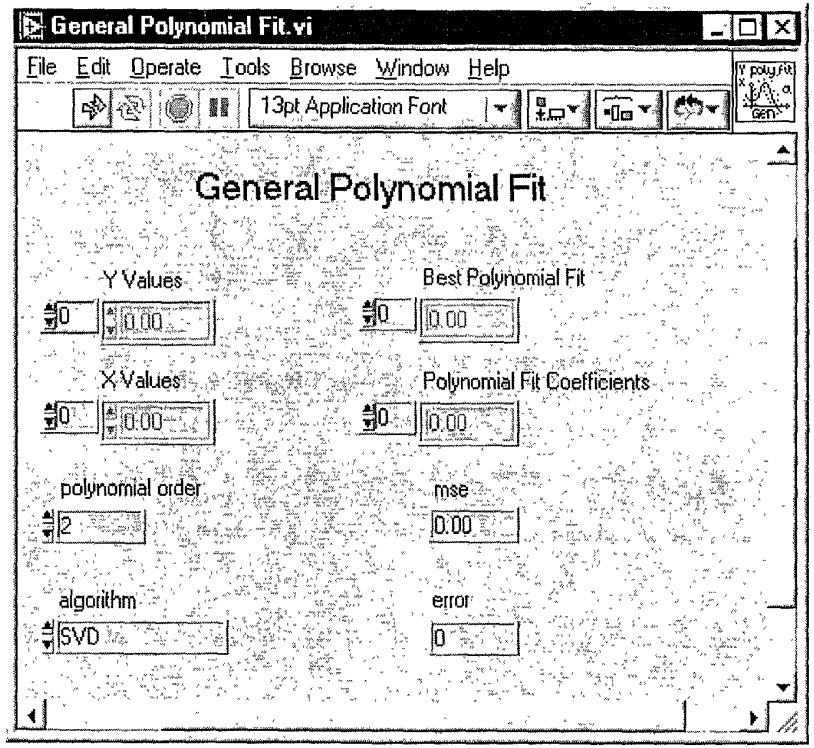

Figure 15A

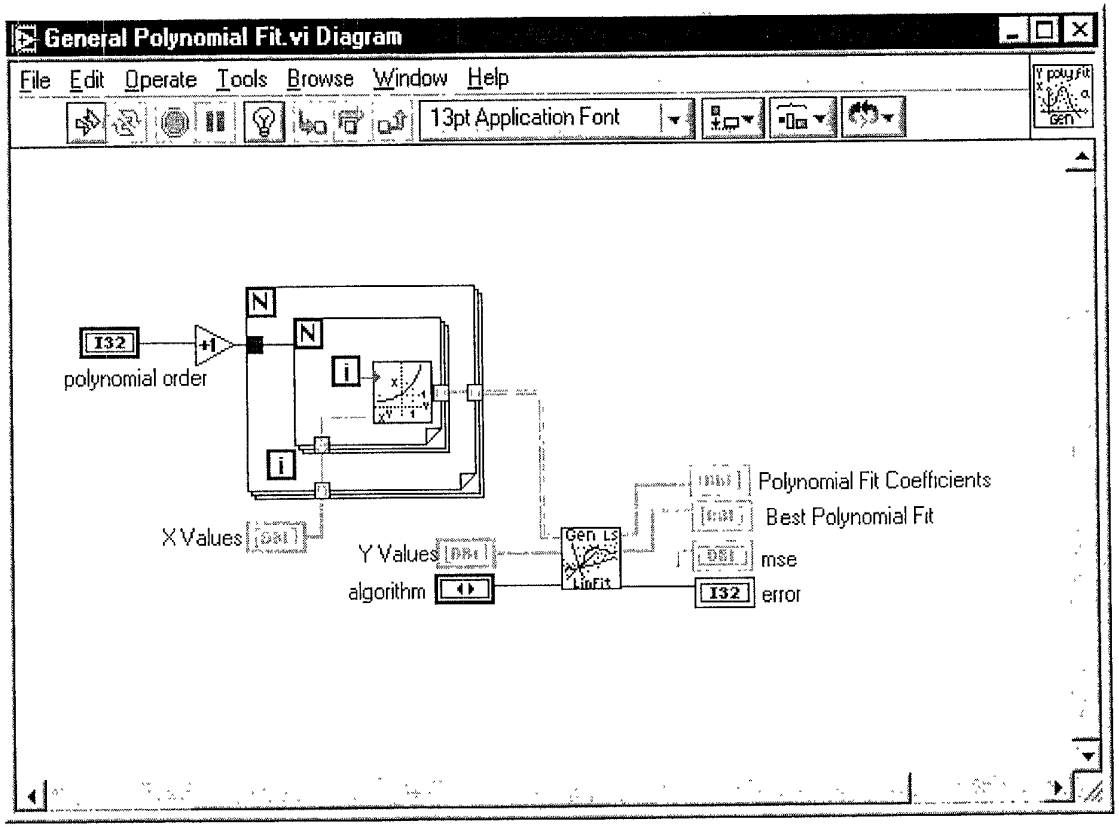
General Polynomial Fit.vi Diagram
File Edit Operate Tools Browse Window Help
13pt Application Font
I32
+1
polynomial order
N
N
i
i
X Values
Y Values
algorithm
Gen LS LinFit
Polynomial Fit Coefficients
Best Polynomial Fit
mse
I32
error

Figure 15B

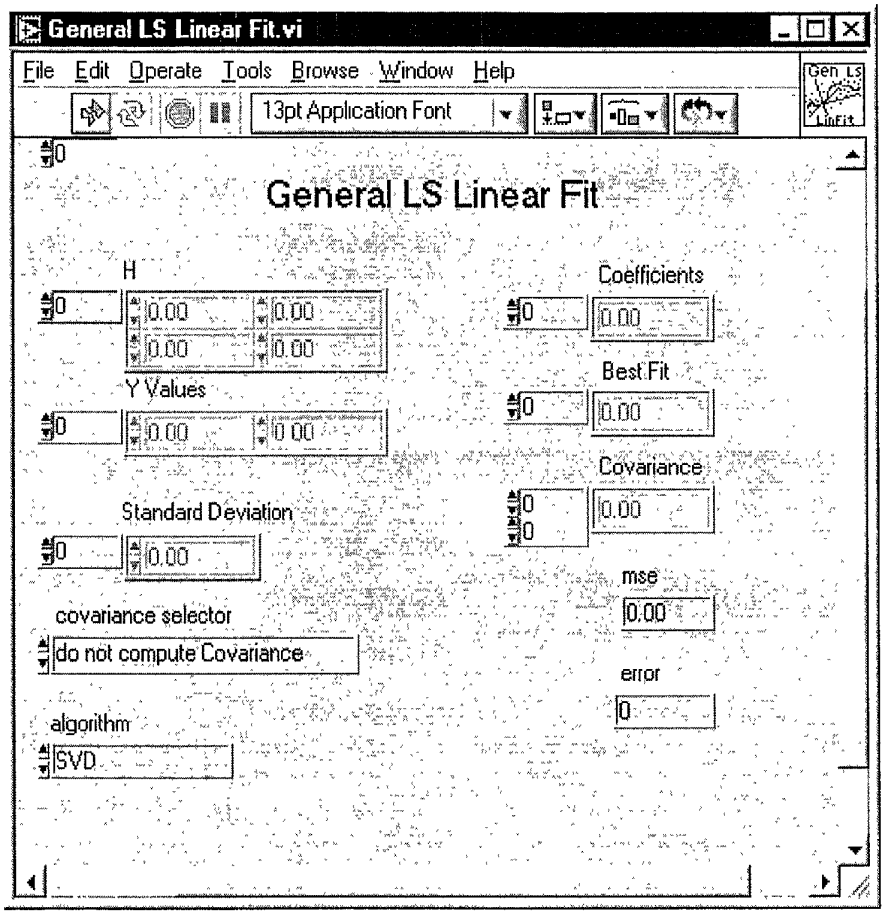
General LS Linear Fit.vi
File Edit Operate Tools Browse Window Help
13pt Application Font
Gen LS LinFit
General LS Linear Fit
H
Y Values
Standard Deviation
covariance selector
do not compute Covariance
algorithm
SVD
Coefficients
Best Fit
Covariance
mse
error

Figure 16A

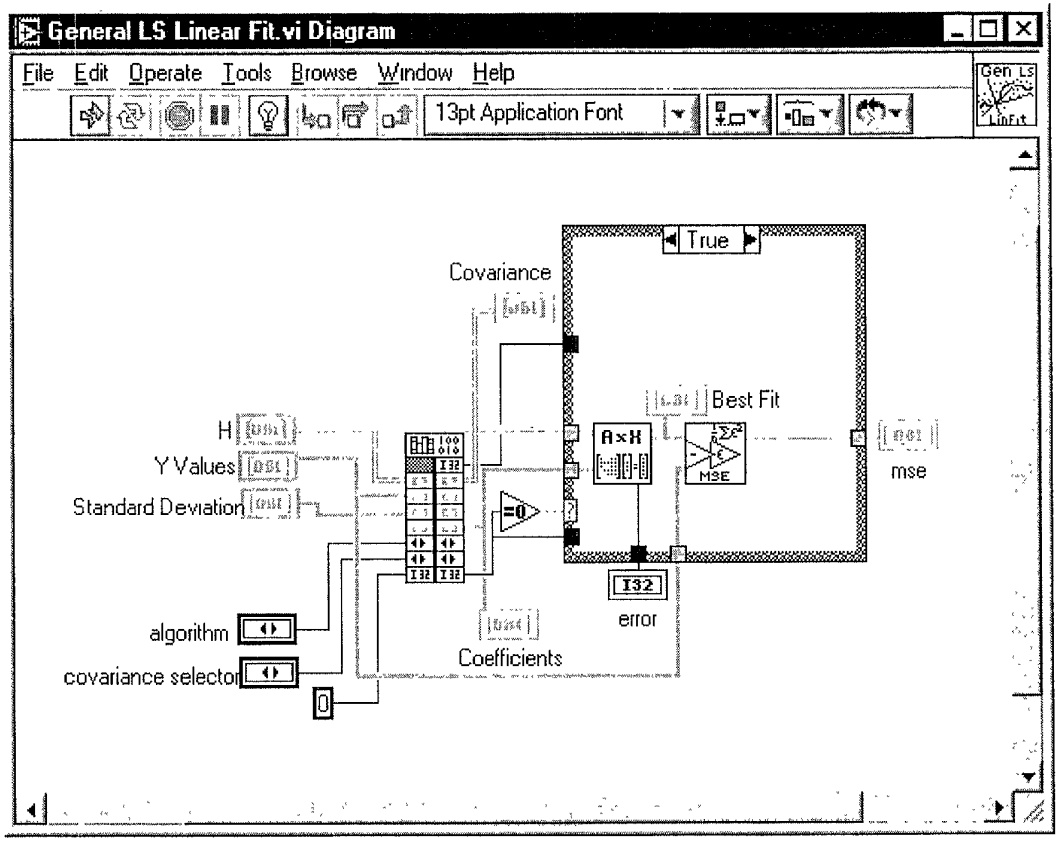
General LS Linear Fit.vi Diagram
File Edit Operate Tools Browse Window Help
13pt Application Font
Gen LS LinFit
True
Covariance
Best Fit
H
Y Values
Standard Deviation
A×H
MSE
mse
I32
error
algorithm
covariance selector
Coefficients
0

Figure 16B

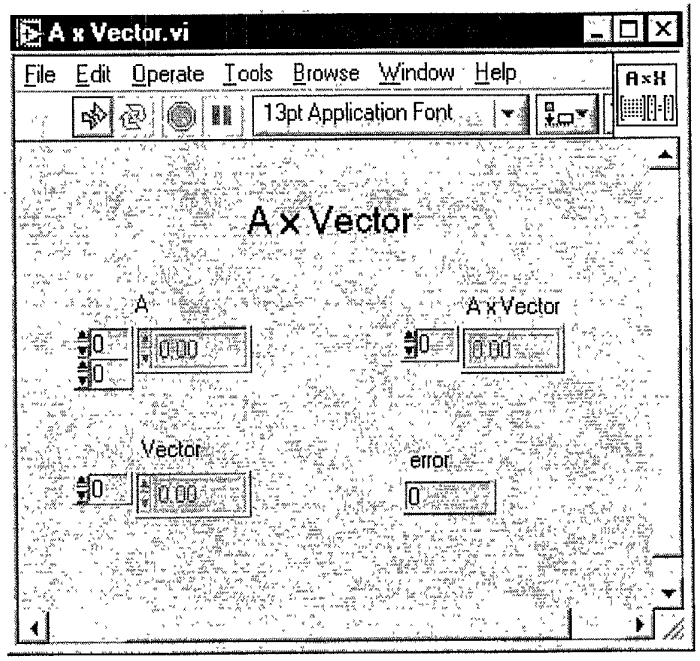
A x Vector.vi
File Edit Operate Tools Browse Window Help
13pt Application Font
A x Vector
A
A x Vector
Vector
error
0.00
0

Figure 17A

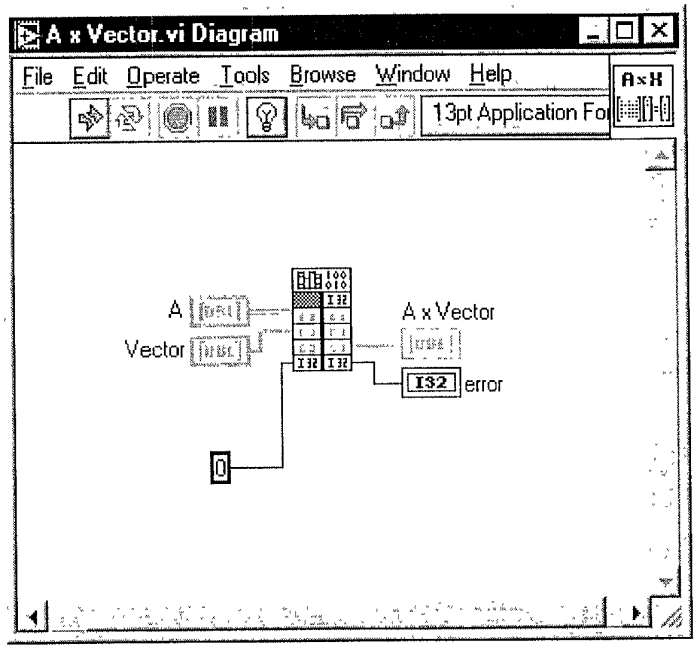
A x Vector.vi Diagram
File Edit Operate Tools Browse Window Help
13pt Application Fo
A
Vector
A x Vector
I32
error
0

Figure 17B

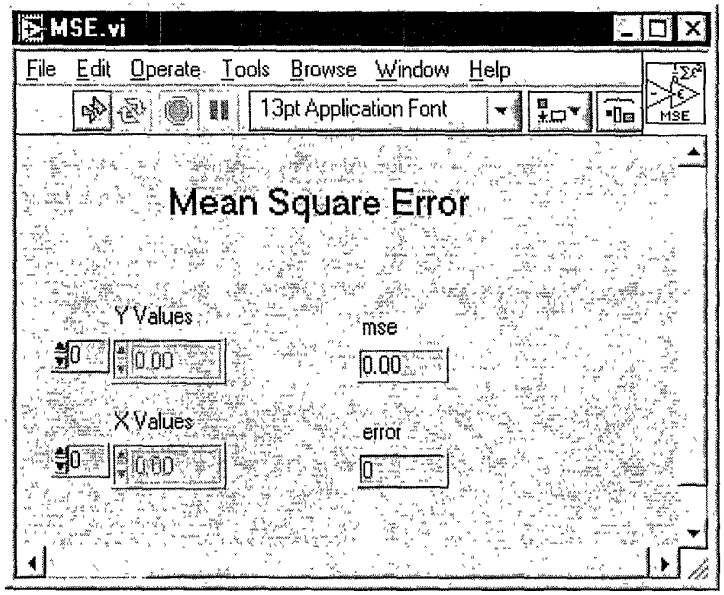
MSE.vi
File Edit Operate Tools Browse Window Help
13pt Application Font
MSE
Mean Square Error
Y Values
0
0.00
X Values
0
0.00
mse
0.00
error
0

Figure 18A

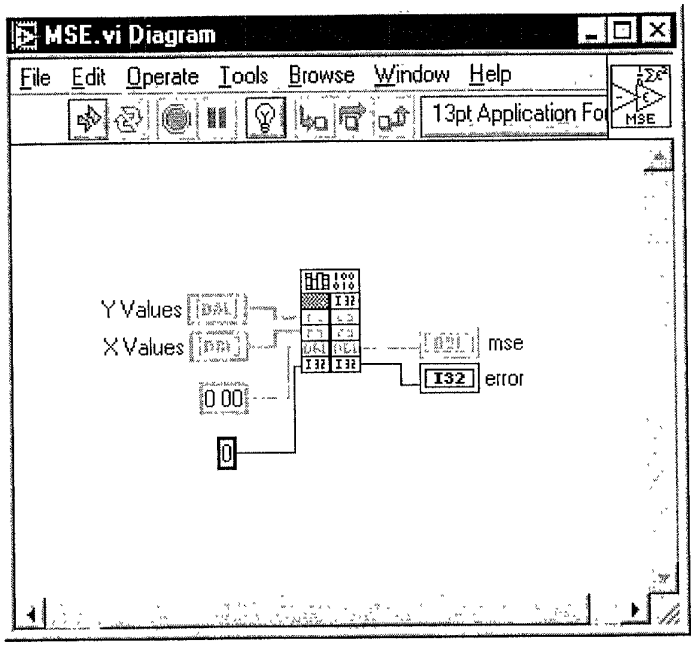
MSE.vi Diagram
File Edit Operate Tools Browse Window Help
13pt Application Fo
MSE
Y Values
X Values
0.00
0
mse
I32
error

Figure 18B

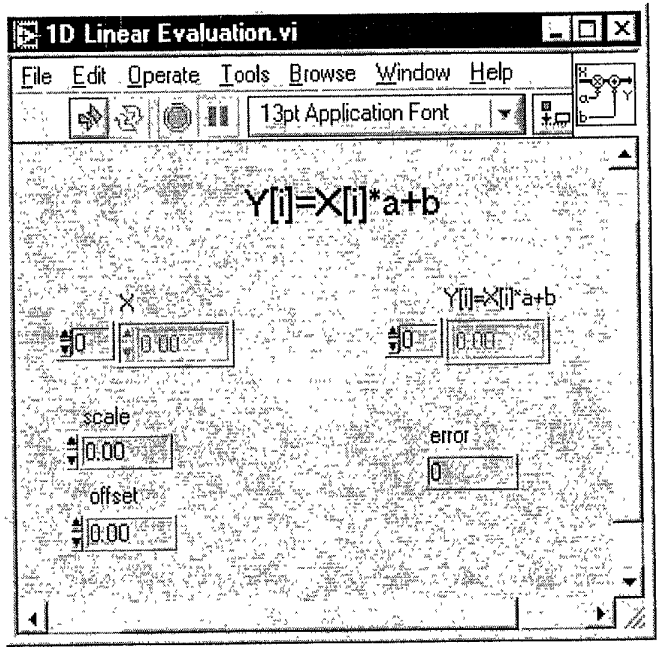
1D Linear Evaluation.vi
File Edit Operate Tools Browse Window Help
13pt Application Font
Y[i]=X[i]*a+b
X
0
0.00
Y[i]=X[i]*a+b
0
0.00
scale
0.00
offset
0.00
error
0

Figure 19A

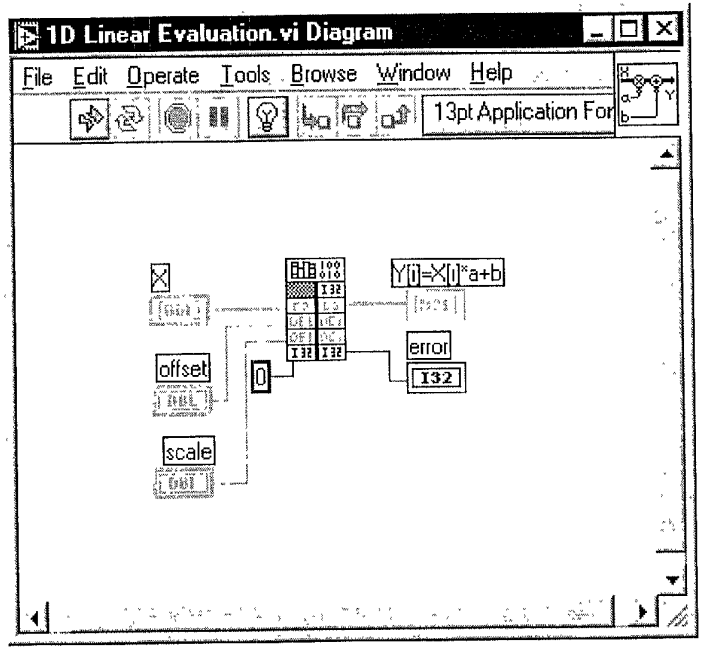
1D Linear Evaluation.vi Diagram
File Edit Operate Tools Browse Window Help
13pt Application For
Y[i]=X[i]*a+b
offset
scale
error
I32
0

Figure 19B

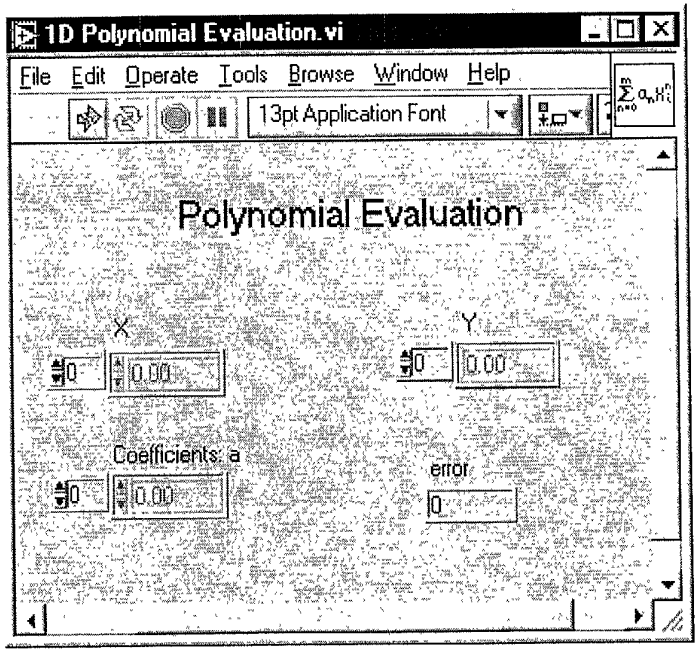
1D Polynomial Evaluation.vi
File Edit Operate Tools Browse Window Help
13pt Application Font
Polynomial Evaluation
X
0
0.00
Y
0
0.00
Coefficients: a
0
0.00
error
0

Figure 20A

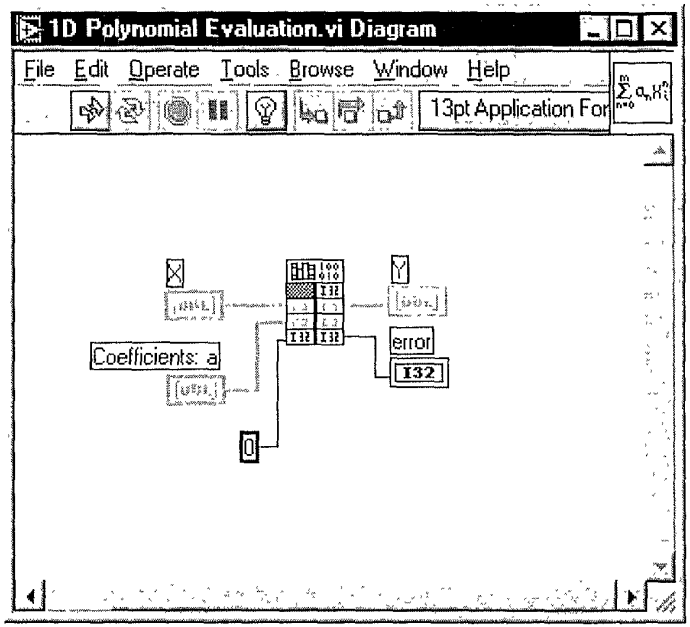
1D Polynomial Evaluation.vi Diagram
File Edit Operate Tools Browse Window Help
13pt Application For
X
Y
Coefficients: a
error
I32
0

Figure 20B

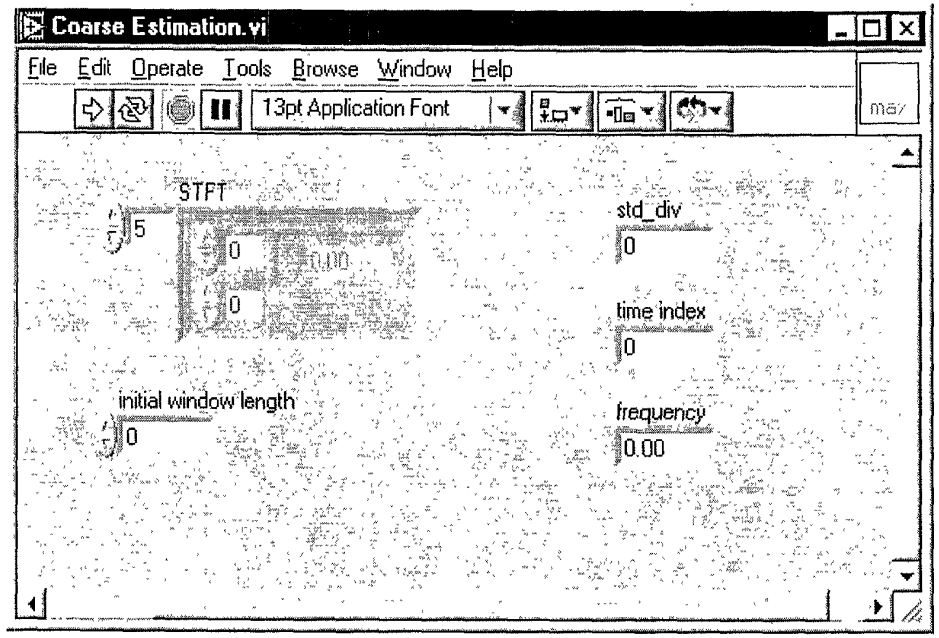
Coarse Estimation.vi
File Edit Operate Tools Browse Window Help
13pt Application Font
STFT
5
0
0.00
0
std_div
0
time index
0
initial window length
0
frequency
0.00

Figure 21A

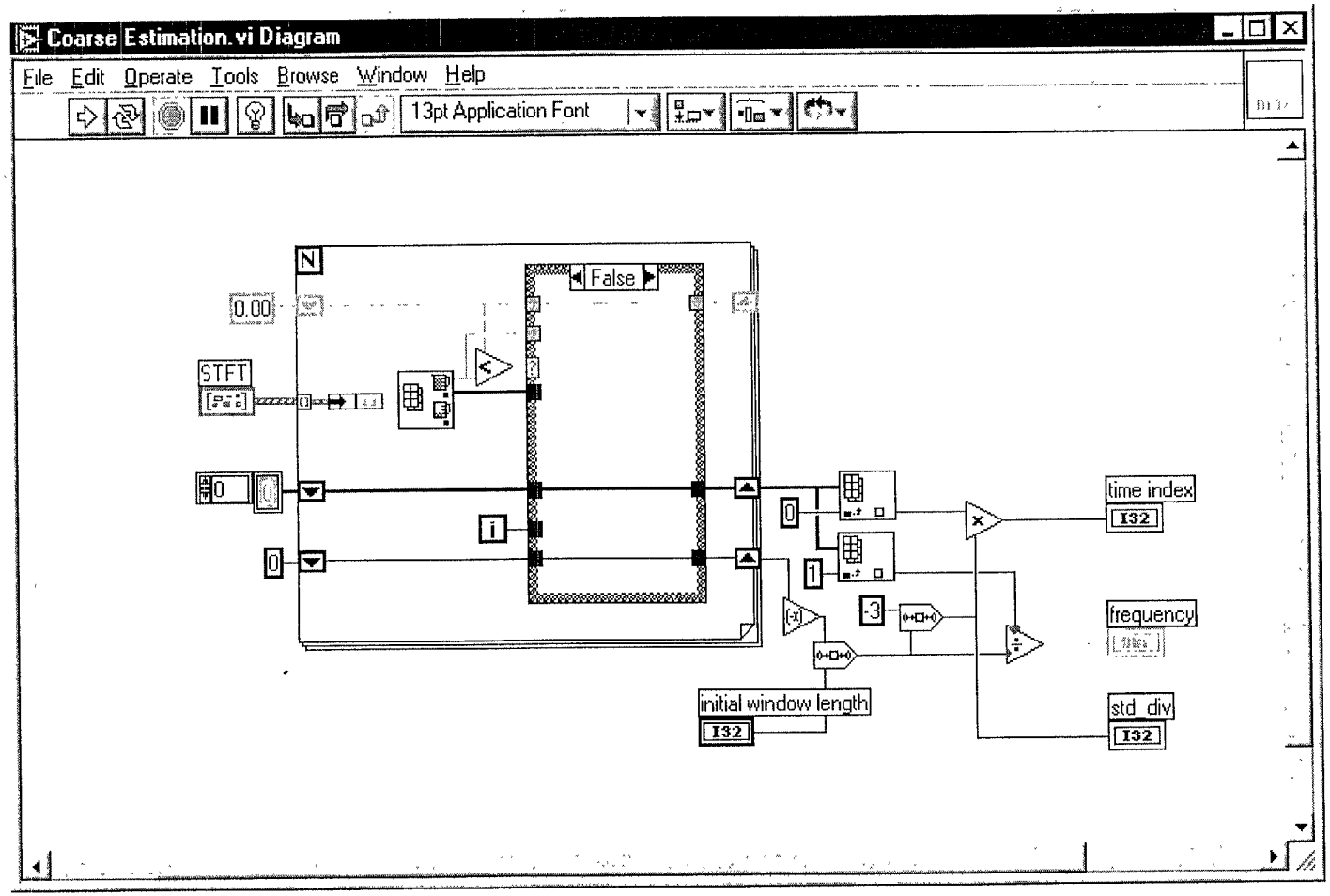
Coarse Estimation.vi Diagram
File Edit Operate Tools Browse Window Help
13pt Application Font
N
False
0.00
STFT
0
i
0
0
1
-3
time index
I32
frequency
std_div
I32
initial window length
I32

Figure 21B

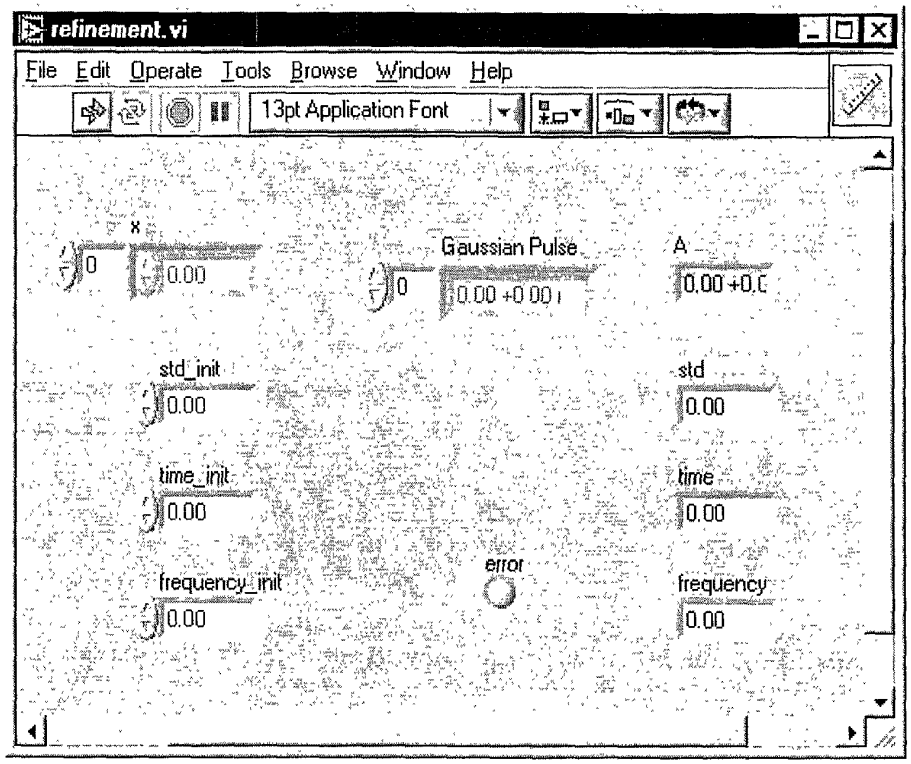
refinement.vi
File Edit Operate Tools Browse Window Help
13pt Application Font
x
0
0.00
Gaussian Pulse
0
0.00 +0.00i
A
0.00 +0.0
std_init
0.00
std
0.00
time_init
0.00
time
0.00
error
frequency_init
0.00
frequency
0.00

Figure 22A

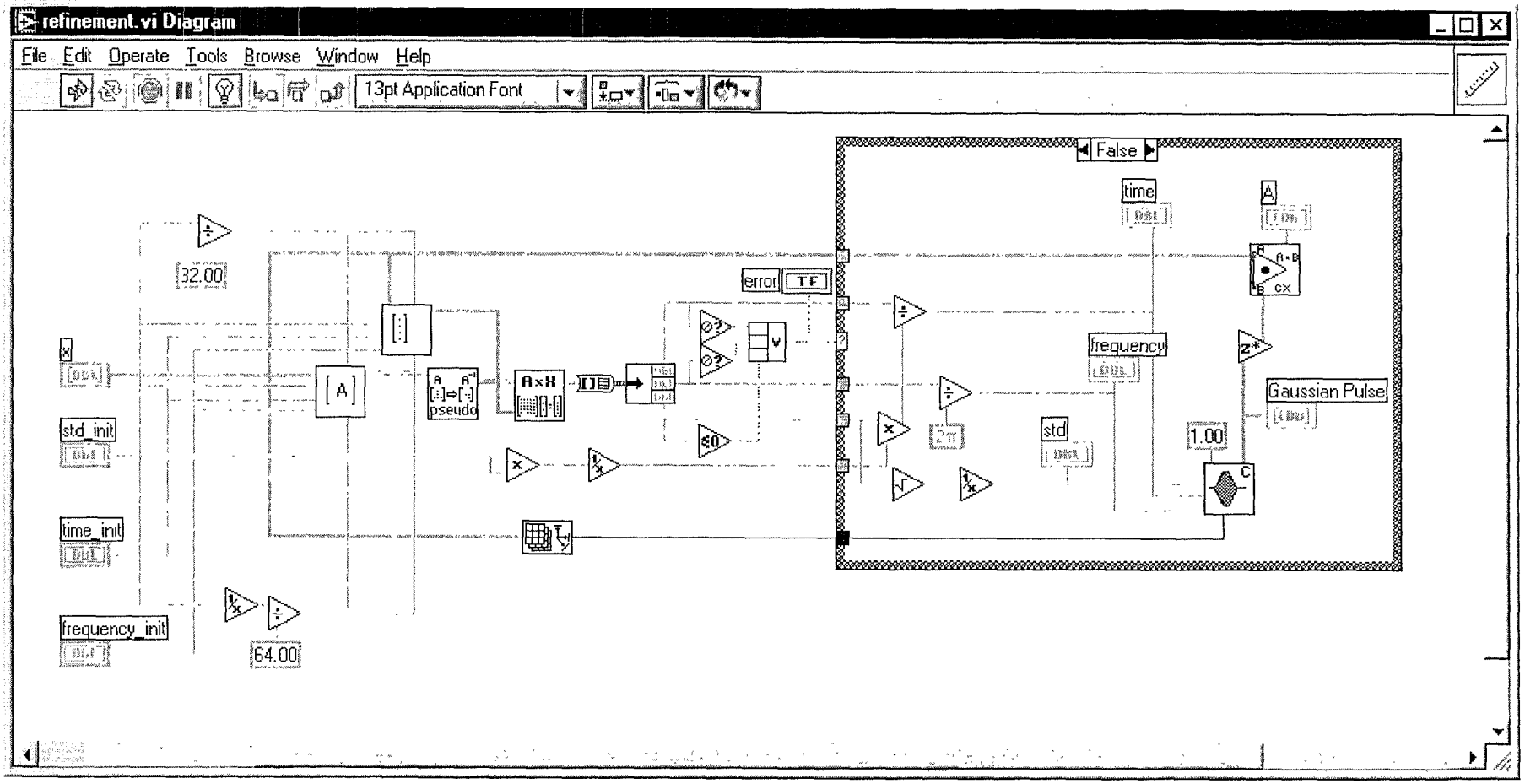
refinement.vi Diagram
File Edit Operate Tools Browse Window Help
13pt Application Font
False
32.00
error
TF
time
frequency
Gaussian Pulse
std
1.00
std_init
time_init
frequency_init
64.00
pseudo

Figure 22B

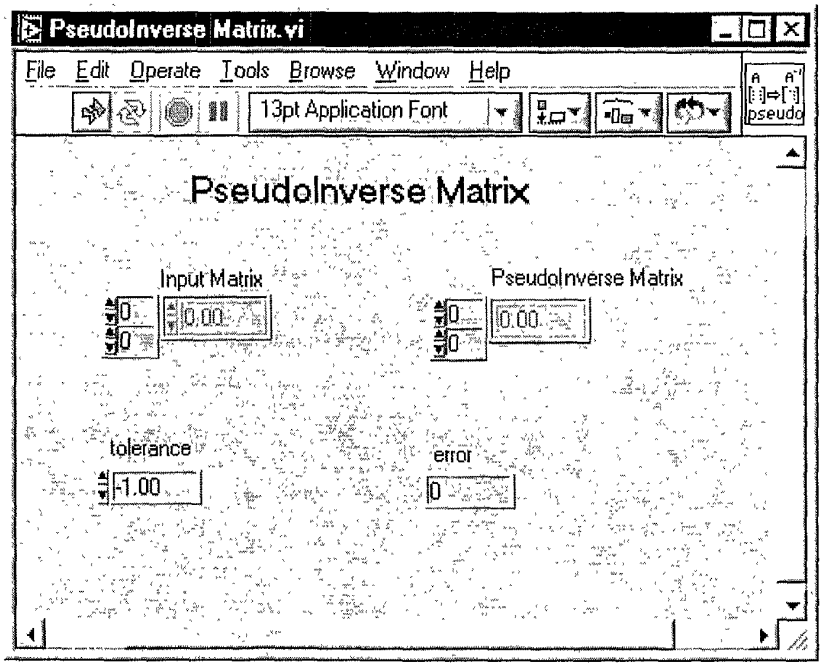
PseudoInverse Matrix.vi
File Edit Operate Tools Browse Window Help
13pt Application Font
pseudo
PseudoInverse Matrix
Input Matrix
0
0
0.00
PseudoInverse Matrix
0
0
0.00
tolerance
-1.00
error
0

Figure 23A

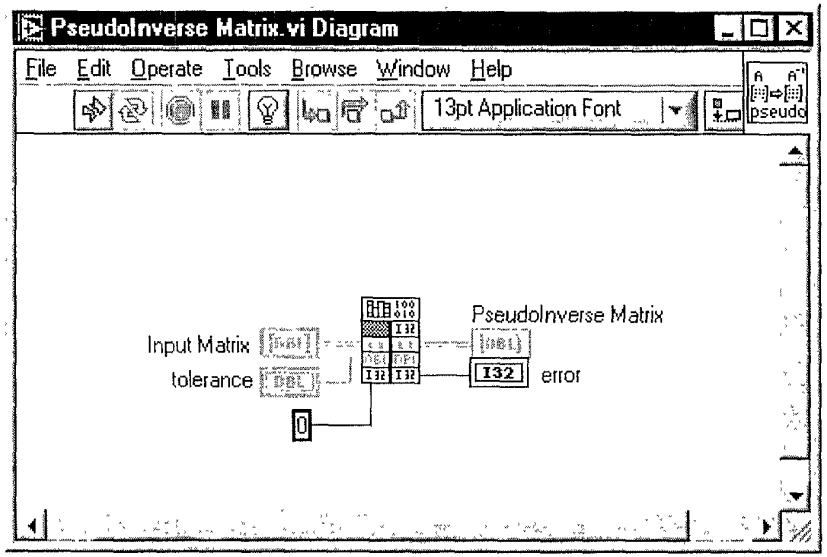
PseudoInverse Matrix.vi Diagram
File Edit Operate Tools Browse Window Help
13pt Application Font
pseudo
Input Matrix
tolerance
PseudoInverse Matrix
error
I32
0

Figure 23B

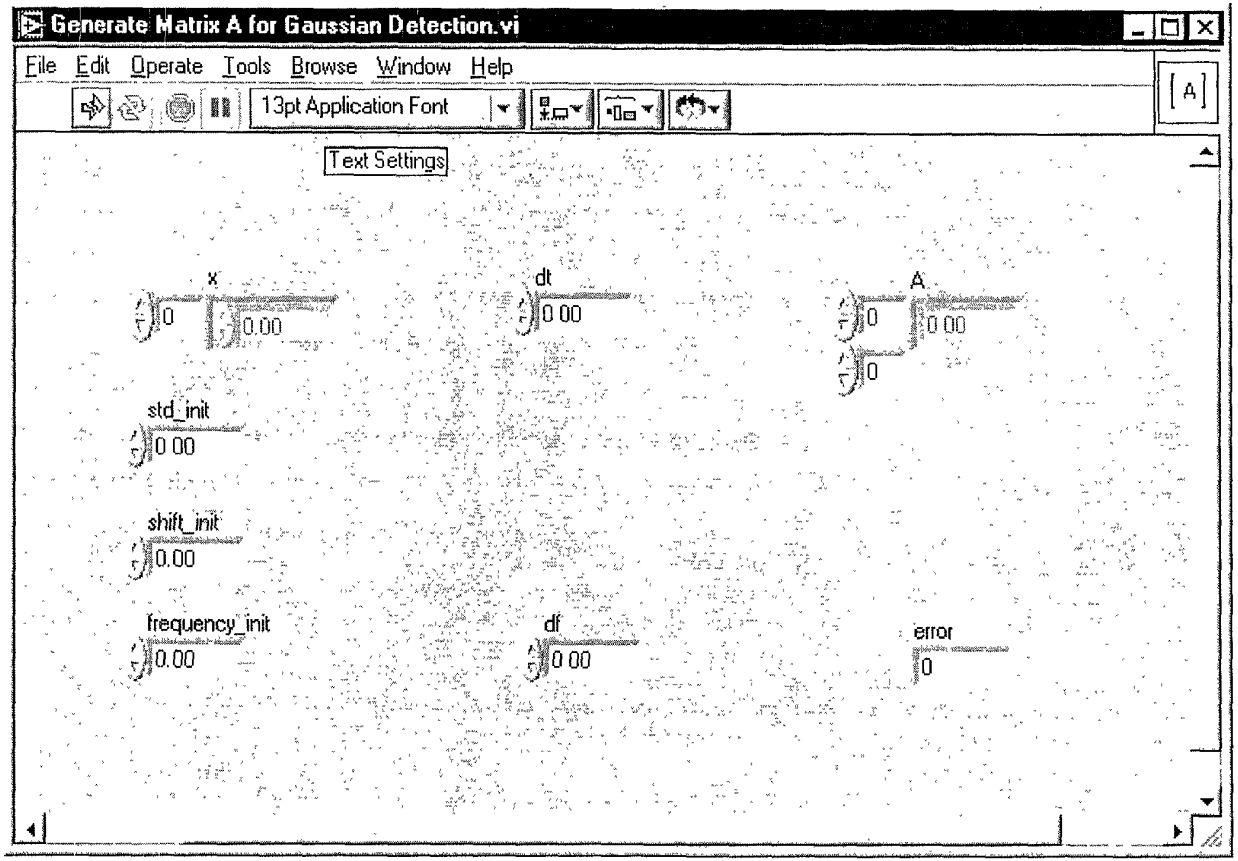
Generate Matrix A for Gaussian Detection.vi
File Edit Operate Tools Browse Window Help
13pt Application Font
Text Settings
x
0
0.00
dt
0.00
A
0
0.00
0
std_init
0.00
shift_init
0.00
frequency_init
0.00
df
0.00
error
0

Figure 24A

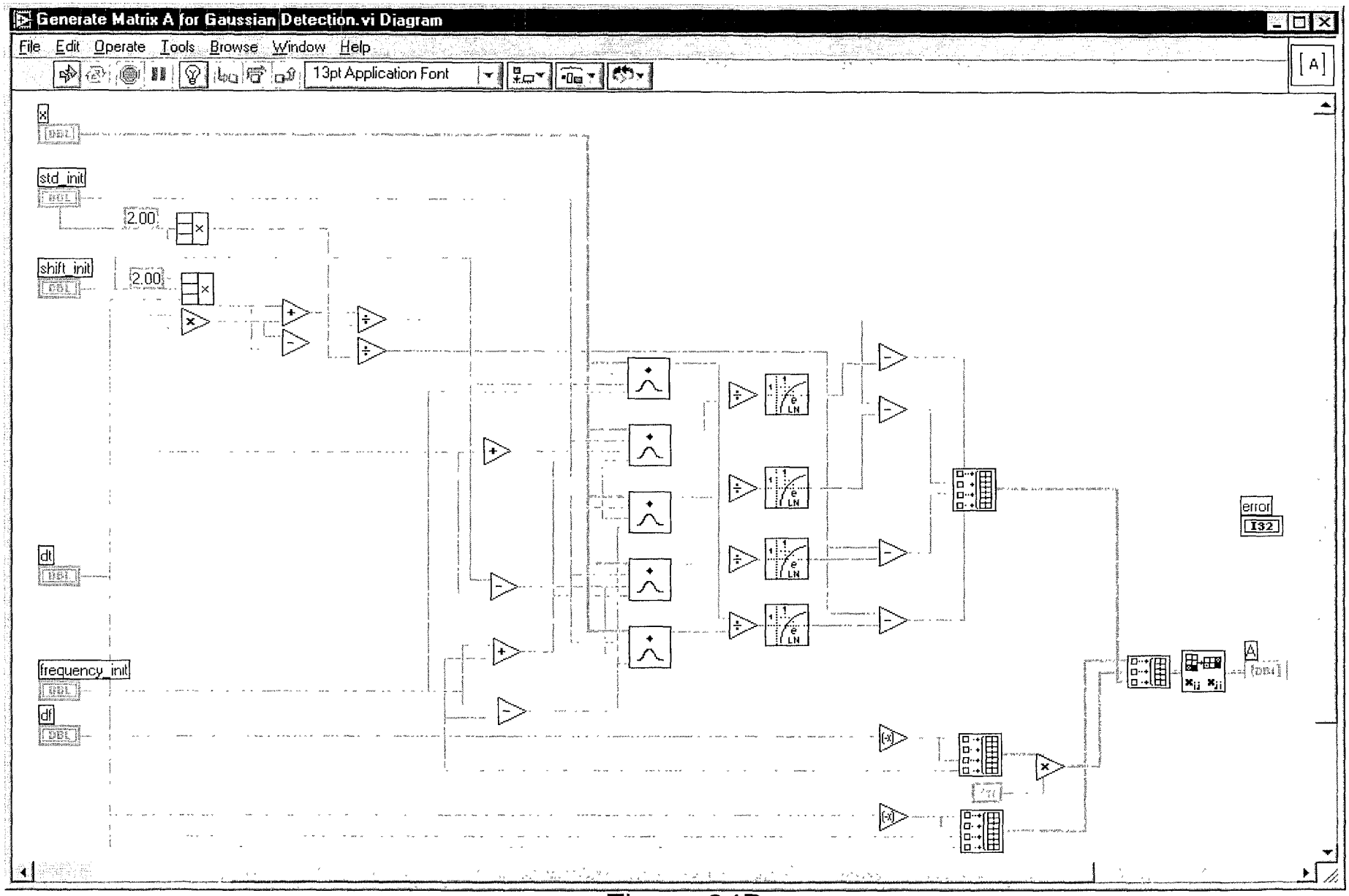
Generate Matrix A for Gaussian Detection.vi Diagram
File Edit Operate Tools Browse Window Help
13pt Application Font
x
std_init
2.00
shift_init
2.00
dt
frequency_init
df
error
I32

Figure 24B

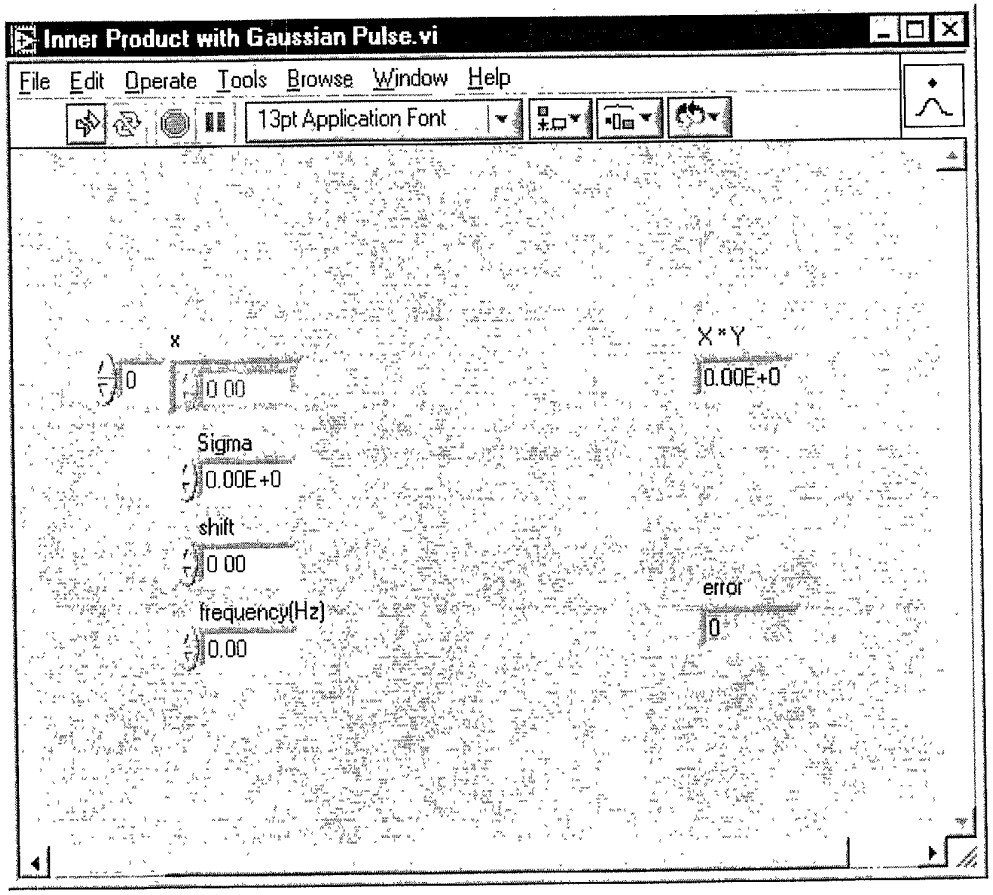
Inner Product with Gaussian Pulse.vi
File Edit Operate Tools Browse Window Help
13pt Application Font
x
0
0.00
Sigma
0.00E+0
shift
0.00
frequency(Hz)
0.00
X*Y
0.00E+0
error
0

Figure 25A

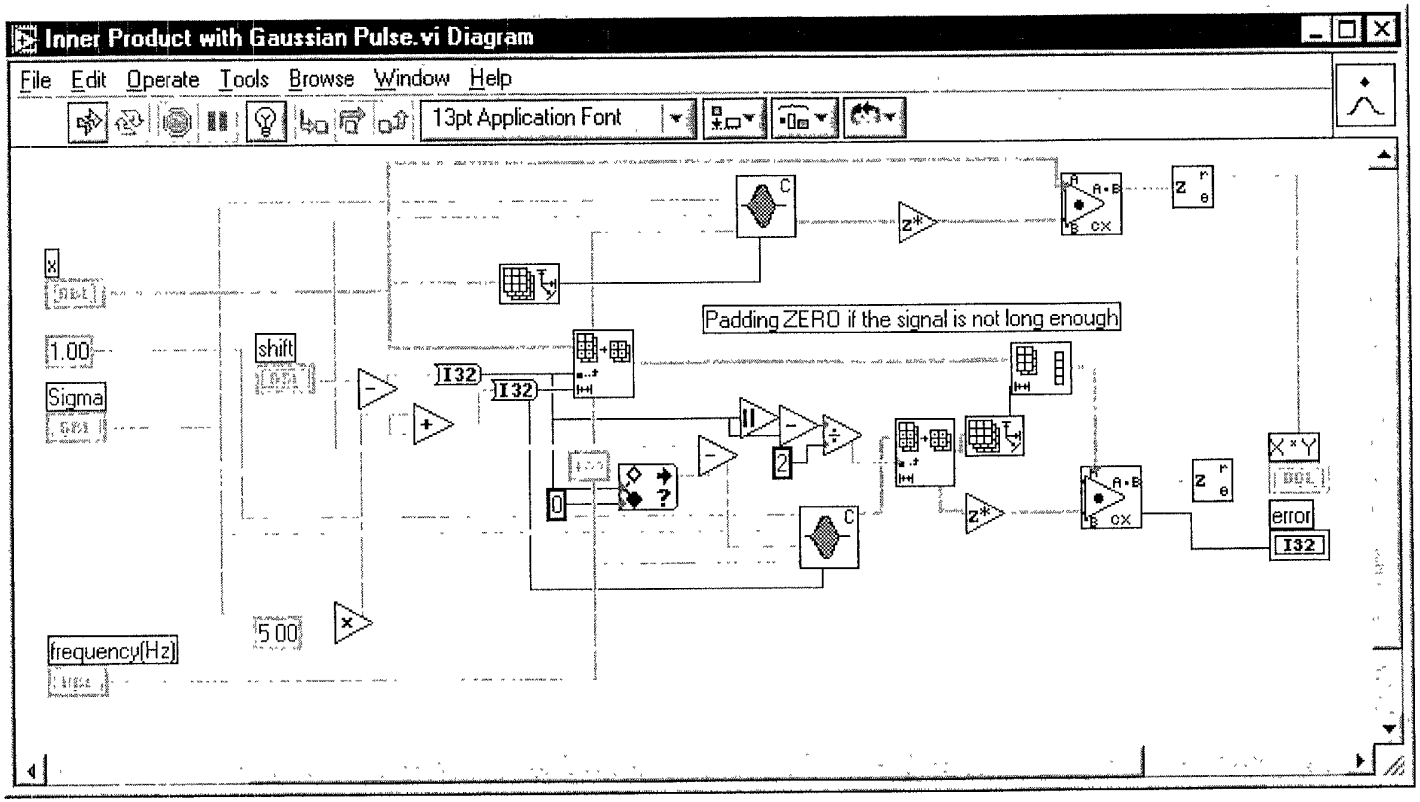
Inner Product with Gaussian Pulse.vi Diagram
File Edit Operate Tools Browse Window Help
13pt Application Font
Padding ZERO if the signal is not long enough
1.00
Sigma
shift
I32
I32
2
0
5.00
frequency(Hz)
error
I32

Figure 25B

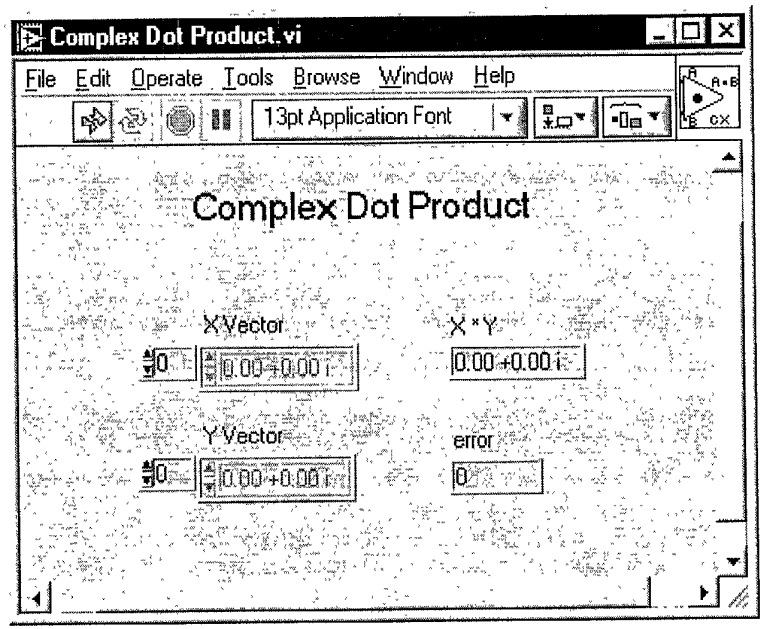
Complex Dot Product.vi
File Edit Operate Tools Browse Window Help
13pt Application Font
Complex Dot Product
X Vector
0
0.00+0.00i
X * Y
0.00+0.00i
Y Vector
0
0.00+0.00i
error
0

Figure 26A

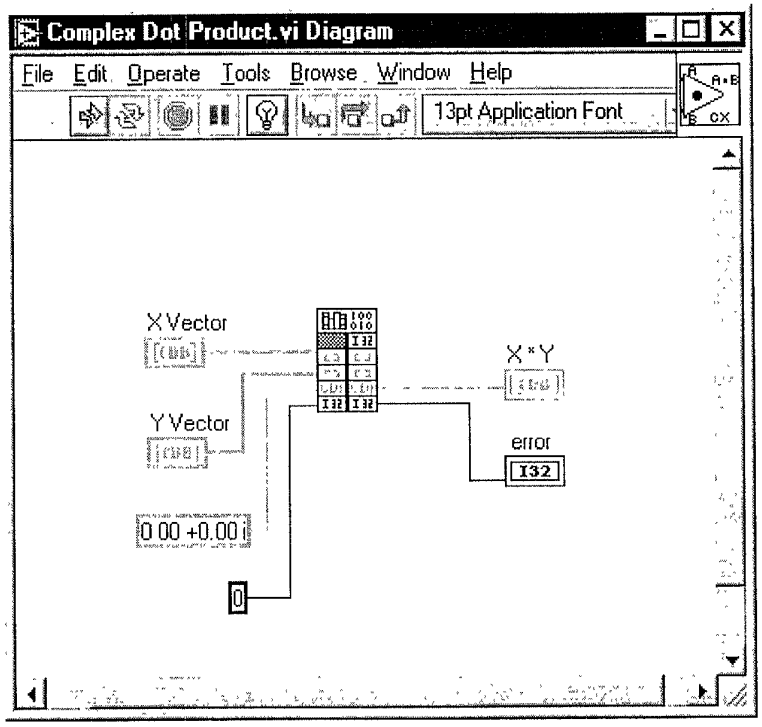
Complex Dot Product.vi Diagram
File Edit Operate Tools Browse Window Help
13pt Application Font
X Vector
Y Vector
0.00 +0.00
X * Y
error
I32
0

Figure 26B

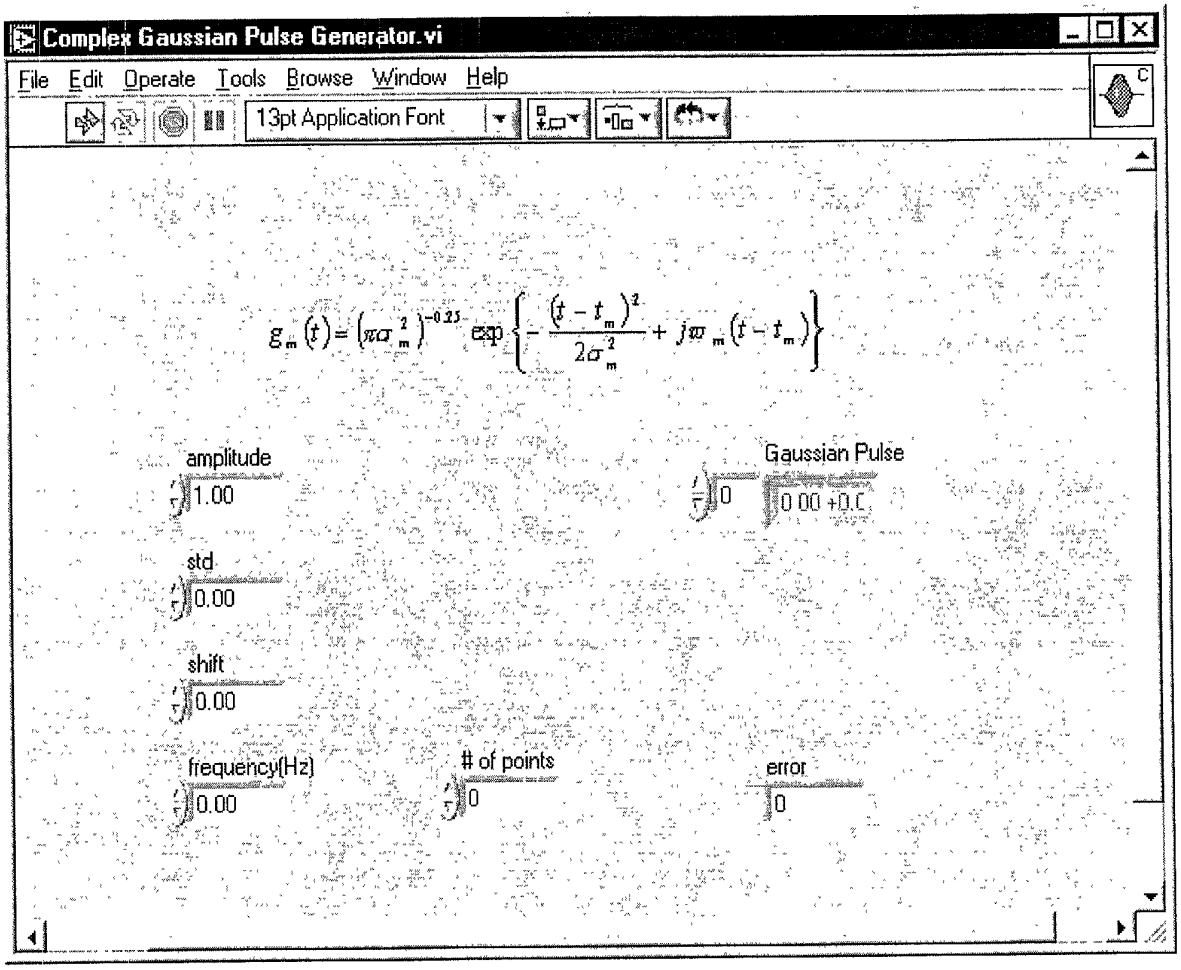
Complex Gaussian Pulse Generator.vi
File Edit Operate Tools Browse Window Help
13pt Application Font
$g_m(t) = (\pi\sigma_m^2)^{-0.25} \exp\left\{-\frac{(t-t_m)^2}{2\sigma_m^2} + j\omega_m(t-t_m)\right\}$
amplitude
1.00
std
0.00
shift
0.00
frequency(Hz)
0.00
# of points
0
Gaussian Pulse
0
0.00 +0.0
error
0

Figure 27A

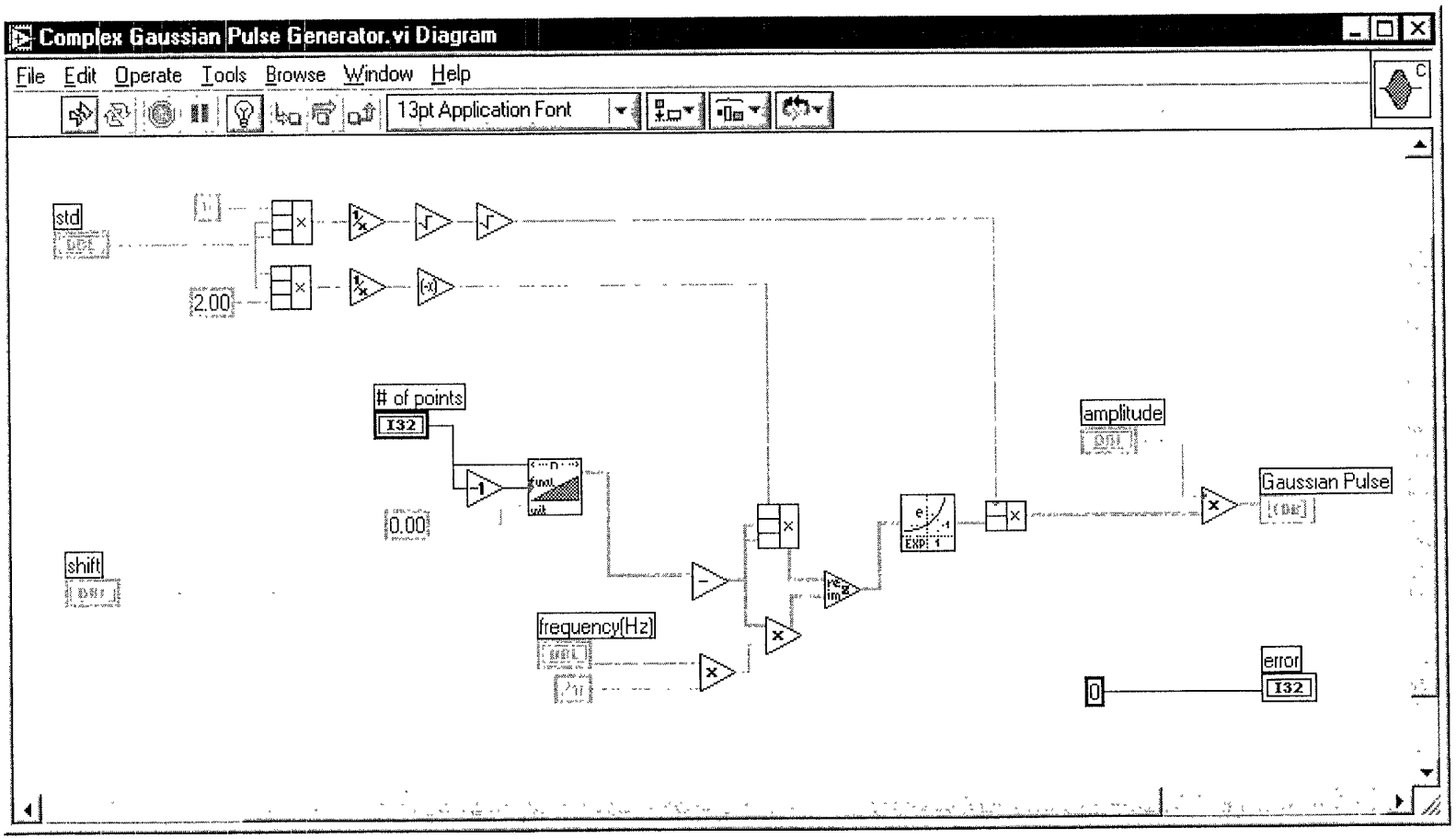
Complex Gaussian Pulse Generator.vi Diagram
File Edit Operate Tools Browse Window Help
13pt Application Font
std
2.00
# of points
I32
-1
0.00
shift
frequency(Hz)
amplitude
Gaussian Pulse
error
I32
0

Figure 27B

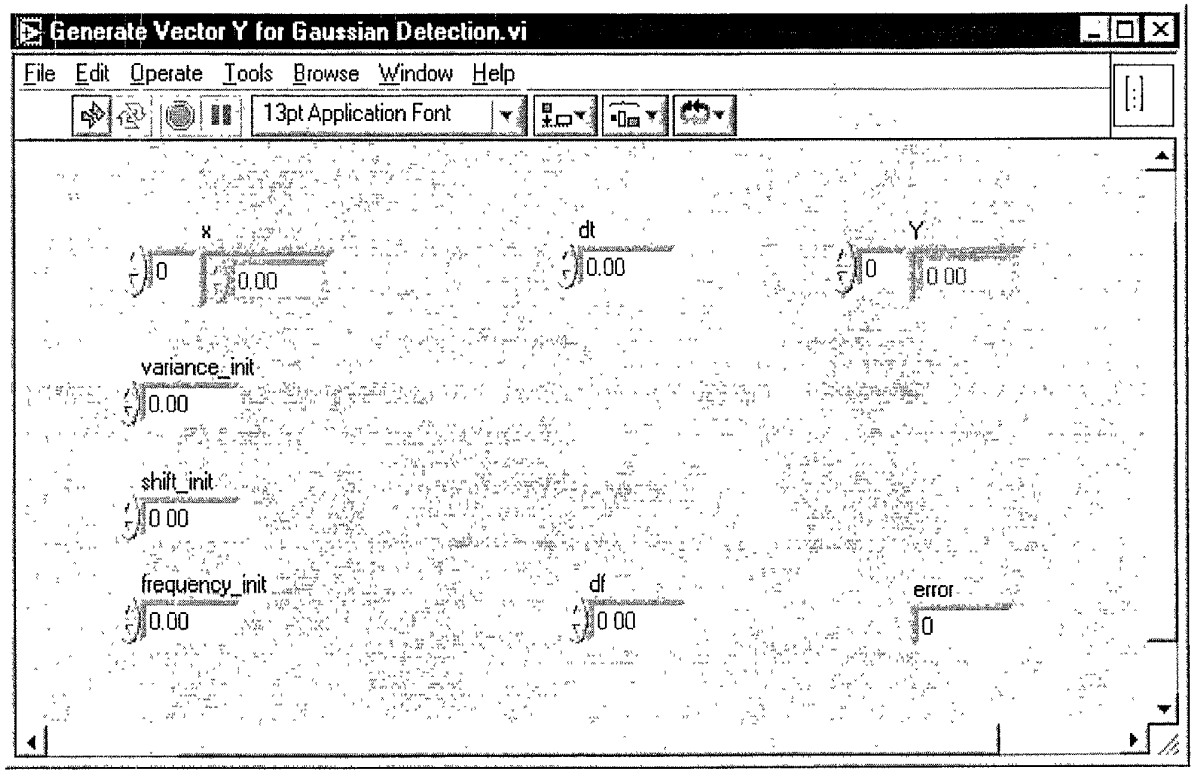
Generate Vector Y for Gaussian Detection.vi
File Edit Operate Tools Browse Window Help
13pt Application Font
x
0
0.00
dt
0.00
Y
0
0.00
variance_init
0.00
shift_init
0.00
frequency_init
0.00
df
0.00
error
0

Figure 28A

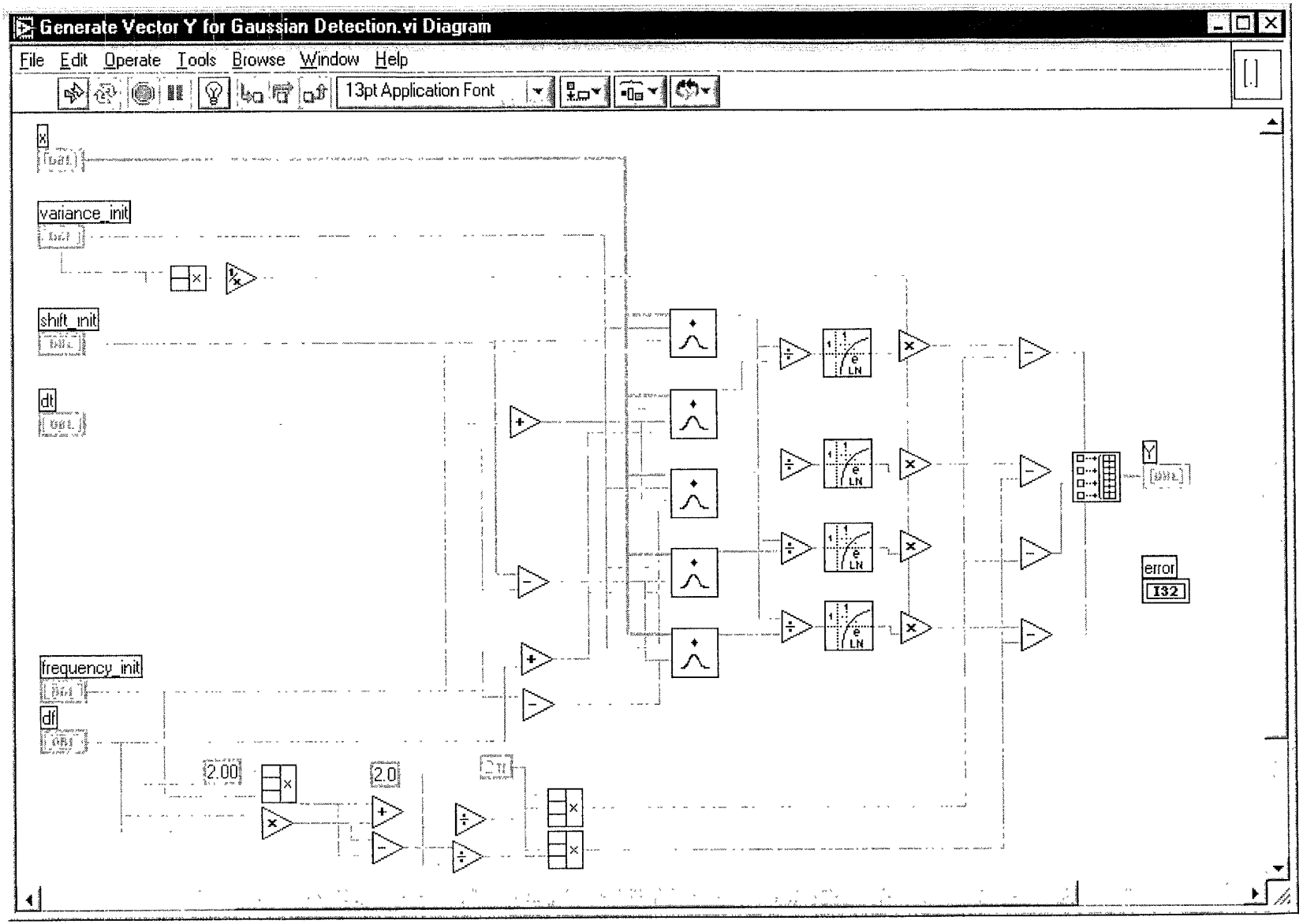
Generate Vector Y for Gaussian Detection.vi Diagram
File Edit Operate Tools Browse Window Help
13pt Application Font
x
variance_init
shift_init
dt
frequency_init
df
2.00
2.0
Y
error
I32

Figure 28B

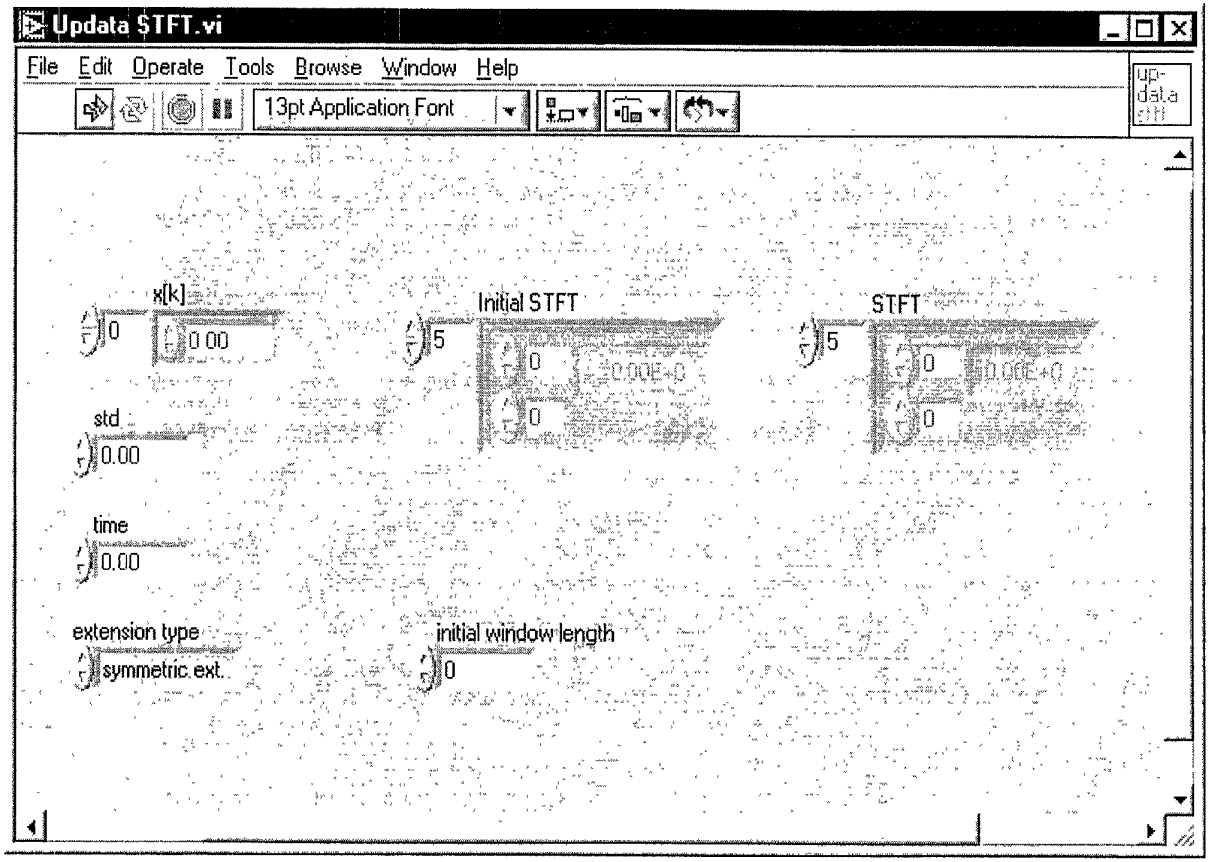
Updata STFT.vi
File Edit Operate Tools Browse Window Help
13pt Application Font
x[k]
0
0.00
Initial STFT
5
0
0.00E+0
0
STFT
5
0
0.00E+0
0
std
0.00
time
0.00
extension type
symmetric ext..
initial window length
0

Figure 29A

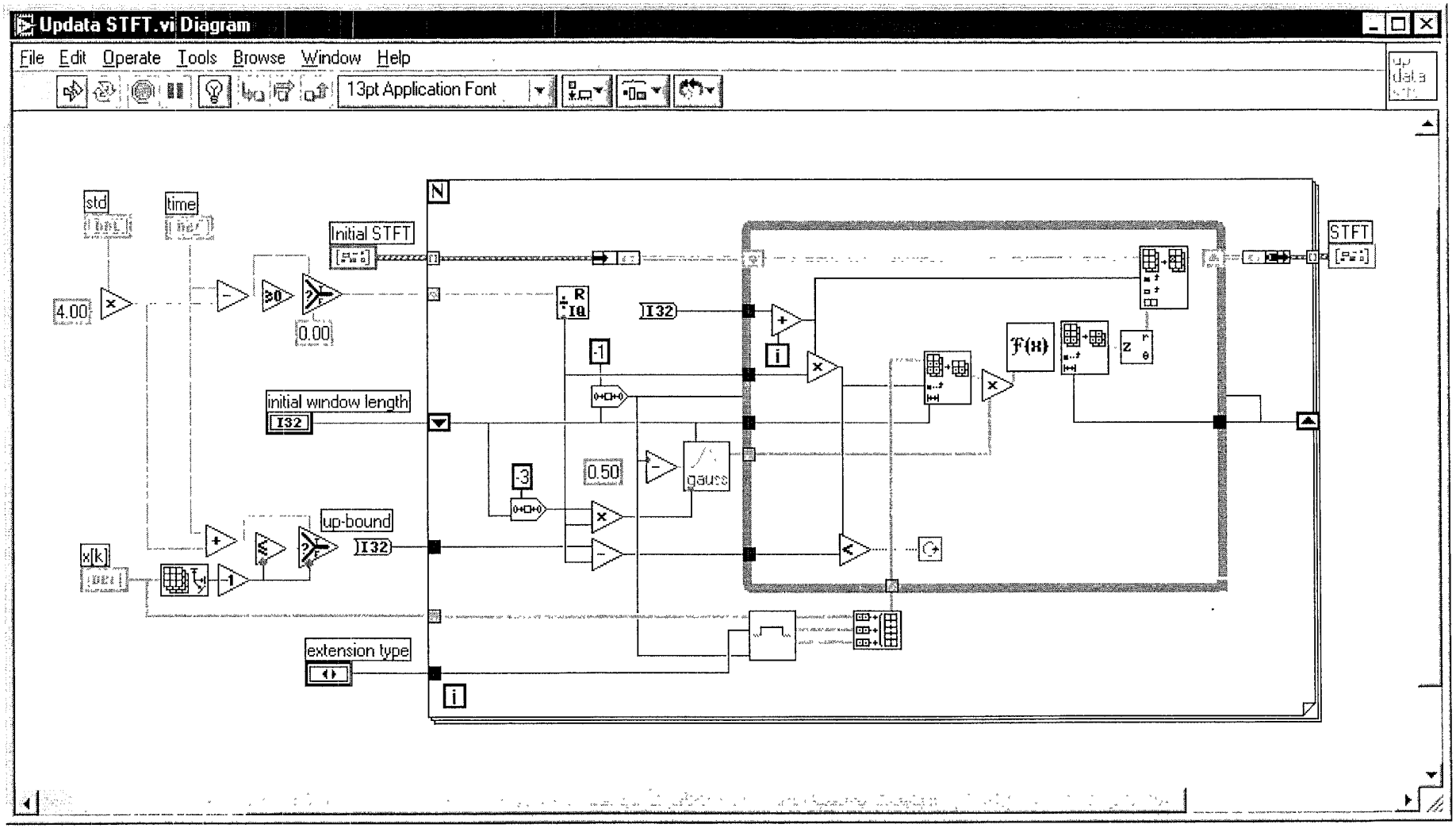
Updata STFT.vi Diagram
File Edit Operate Tools Browse Window Help
13pt Application Font
std
time
Initial STFT
STFT
4.00
0.00
initial window length
I32
up-bound
I32
x[k]
extension type
-1
-3
0.50
gauss
F(x)
i

Figure 29B

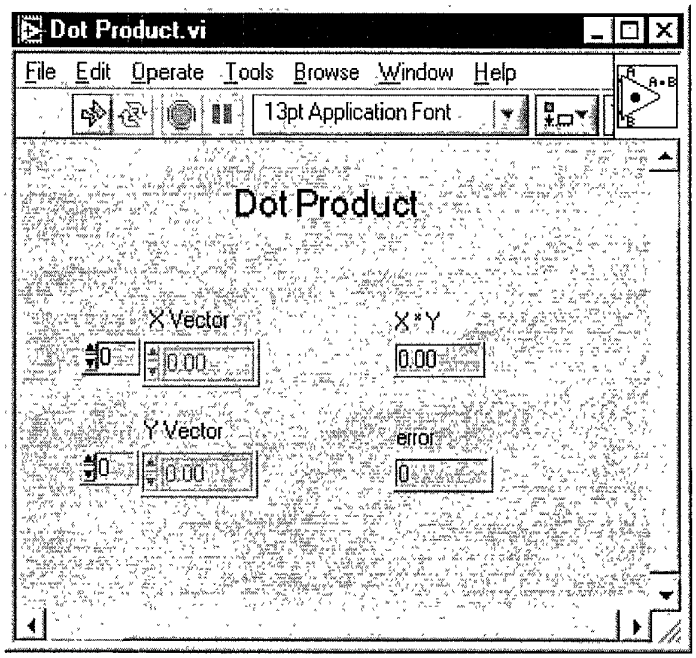
Dot Product.vi
File Edit Operate Tools Browse Window Help
13pt Application Font
Dot Product
X Vector
0
0.00
Y Vector
0
0.00
X*Y
0.00
error
0

Figure 30A

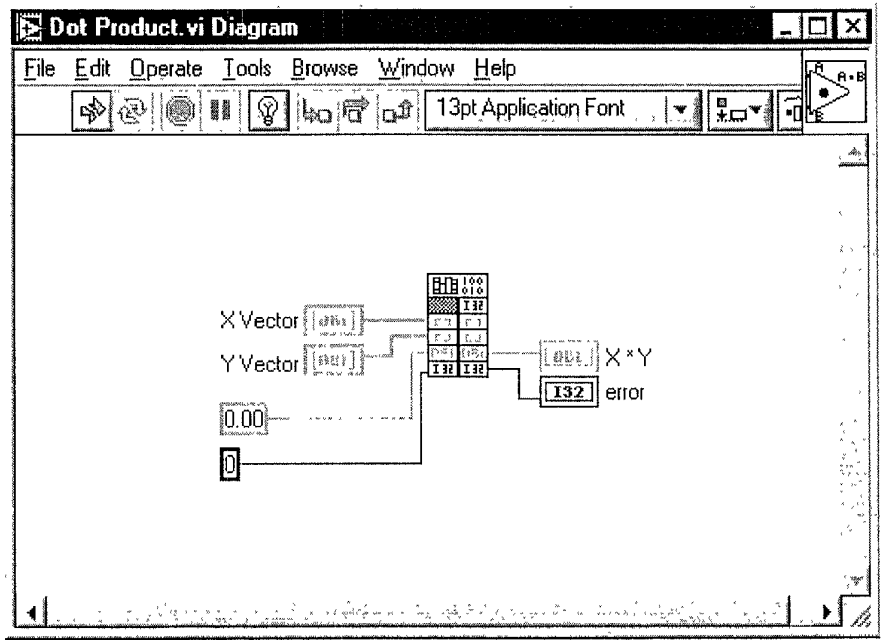
Dot Product.vi Diagram
File Edit Operate Tools Browse Window Help
13pt Application Font
X Vector
Y Vector
0.00
X * Y
error

Figure 30B

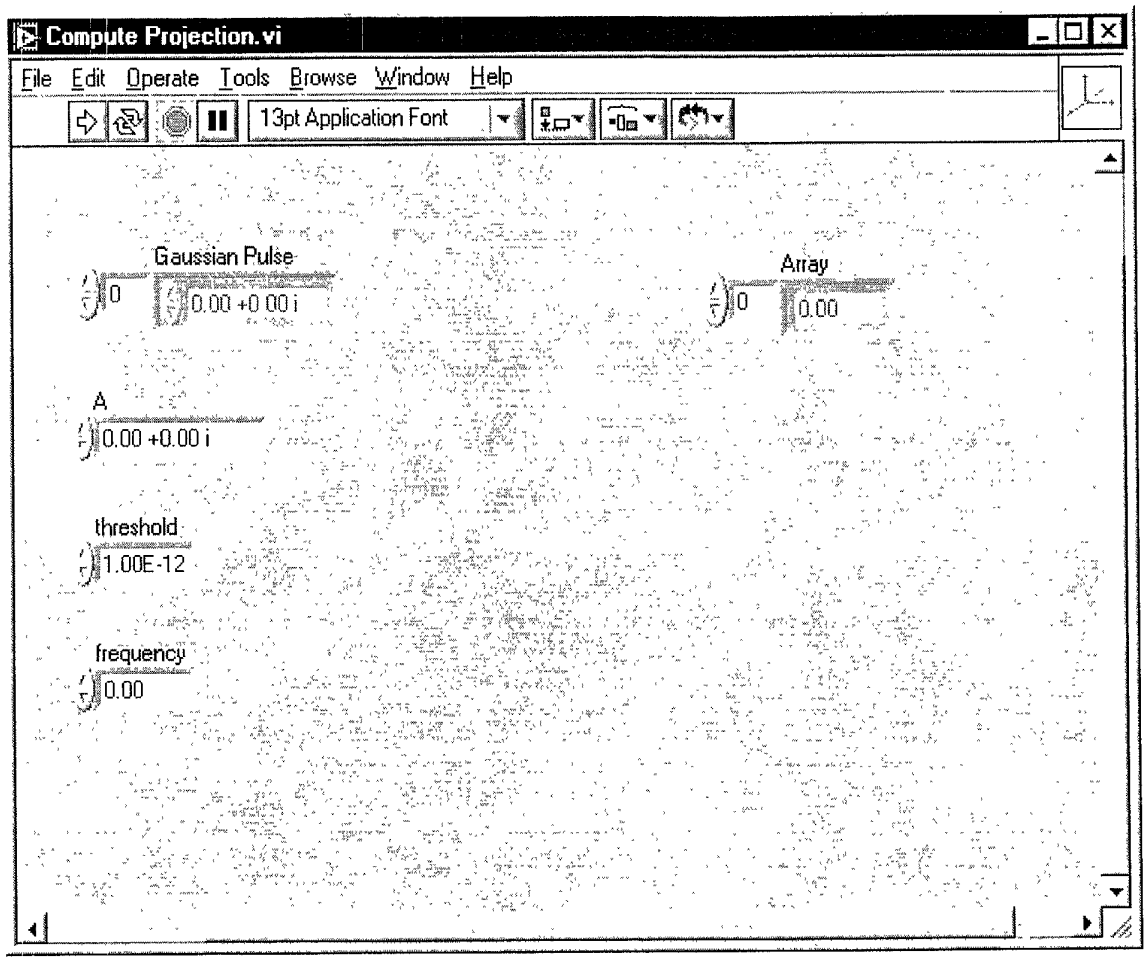
Compute Projection.vi
File Edit Operate Tools Browse Window Help
13pt Application Font
Gaussian Pulse
0
0.00 +0.00 i
Array
0
0.00
A
0.00 +0.00 i
threshold
1.00E-12
frequency
0.00

Figure 31A

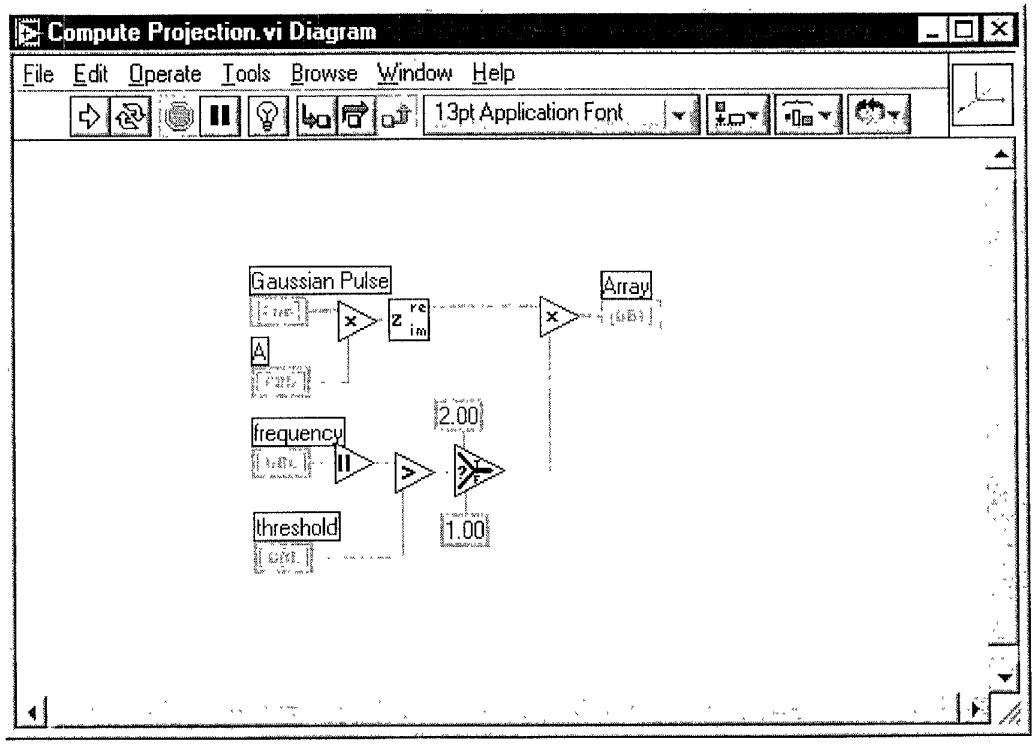
Compute Projection.vi Diagram
File Edit Operate Tools Browse Window Help
13pt Application Font
Gaussian Pulse
Array
A
frequency
2.00
threshold
1.00

Figure 31B

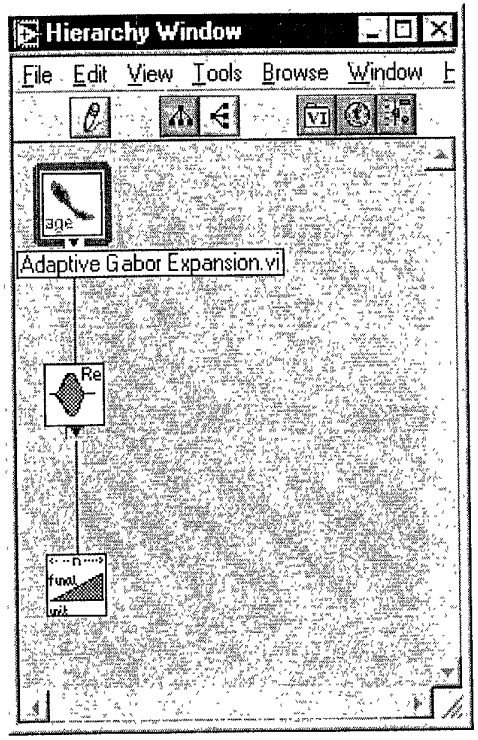
Hierarchy Window
File Edit View Tools Browse Window
Adaptive Gabor Expansion.vi
Re

Figure 32

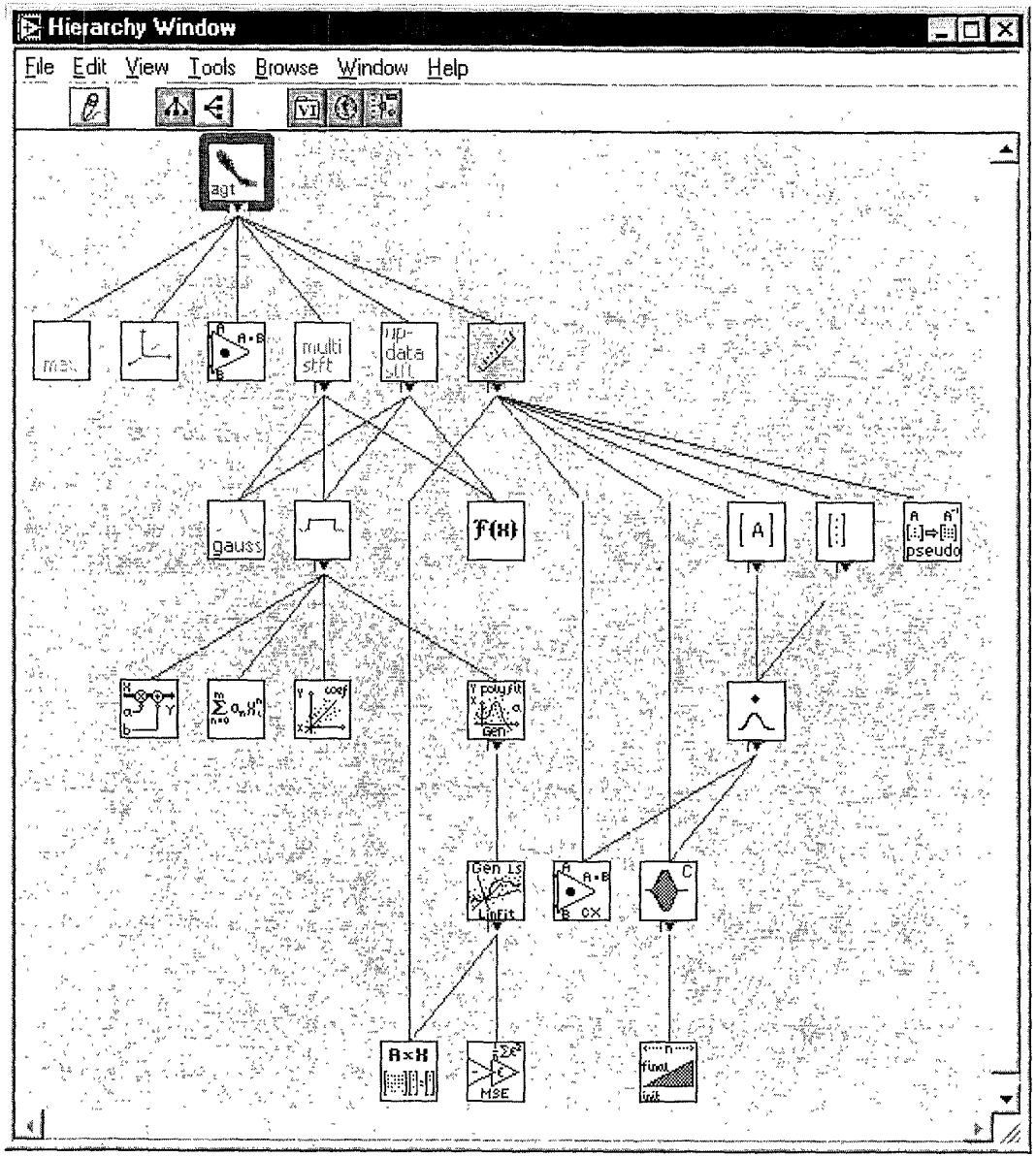
Hierarchy Window
File Edit View Tools Browse Window Help
agt
multi shft
up-data shft
gauss
F(x)
pseudo
poly fit
Gen
Gen LS
LinFit
MSE

Figure 33